VI. Compliance with Standard Terms and Conditions

The applicant agrees with the terms and conditions set forth in "Attachment D: Terms and Conditions for State (CALFED) Funds." (See attached)

Additionally, as directed in Table D-1: Standard Contract Clauses and Related Proposal Submittal Requirements, the following signed and completed forms are attached relative to a non-profit organization applying for services/preconstruction/research topics:

Service and Consultant with Non Public Entity
Non-Discrimination Compliance
Non Collusion

ITEM 10

Agreement No. ________

Exhibit ________

NONCOLLUSION AFFIDAVIT TO BE EXECUTED BY BIDDER AND SUBMITTED WITH BID FOR PUBLIC WORKS

STATE OF CALIFORNIA)
)ss
COUNTY OF NEVADA)

SHAWN GARVEY, being first duly sworn, deposes and
(name)

says that he or she is EXECUTIVE DIRECTOR of
(position title)

SOUTH YUBA RIVER CITIZENS LEAGUE,
(the bidder)

the party making the foregoing bid that the bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the bid is genuine and not collusive or sham; that the bidder has not directly or indirectly induced or solicited any other bidder to put in a false sham bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or that anyone shall refrain from bidding; that the bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder, or to secure any advantage against the public body awarding the contract of anyone interested in the proposed contract; that all statements contained in the bid are true; and, further, that the bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid.

DATED: 6·30·98

By Estelle Barber
(person signing for bidder)

ROBERT L. BUHLIS
Commission #1173003
NOTARY PUBLIC - CALIFORNIA
NEVADA COUNTY
MY COMMISSION EXPIRES
FEBRUARY 7, 2002

(Notarial Seal)

Subscribed and sworn to before me on 30 JUNE 1998

Robert L Buhlis
(Notary Public)

Agreement No. ________

Exhibit __________

STANDARD CLAUSES— SERVICE & CONSULTANT SERVICE CONTRACTS FOR $5,000 & OVER WITH NONPUBLIC ENTITIES

Workers' Compensation Clause. Contractor affirms that it is aware of the provisions of Section 3700 of the California Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self insurance in accordance with the provisions of that Code, and Contractor affirms that it will comply with such provisions before commencing the performance of the work under this contract.

Claims Dispute Clause. Any claim that Contractor may have regarding the performance of this agreement including, but not limited to, claims for additional compensation or extension of time, shall be submitted to the Director, Department of Water Resources, within thirty days of its accrual. State and Contractor shall then attempt to negotiate a resolution of such claim and process an amendment to this agreement to implement the terms of any such resolution.

National Labor Relations Board Clause. In accordance with Public Contract Code Section 10296, Contractor declares under penalty of perjury that no more than one final, unappealable finding of contempt of court by a federal court has been issued against the Contractor within the immediately preceding two-year period because of Contractor's failure to comply with an order of a federal court which orders Contractor to comply with an order of the National Labor Relations Board.

Nondiscrimination Clause. During the performance of this contract, the recipient, contractor and its subcontractors shall not deny the contract's benefits to any person on the basis of religion, color, ethnic group identification, sex, age, physical or mental disability, nor shall they discriminate unlawfully against any employee or applicant for employment because of race, religion, color, national origin, ancestry, physical handicap, mental disability, medical condition, marital status, age (over 40), or sex. Contractor shall insure that the evaluation and treatment of employees and applicants for employment are free of such discrimination. Contractor shall comply with the provisions of the Fair Employment and Housing Act (Government Code Section 12900 et seq.), the regulations promulgated thereunder (California Administrative Code, Title 2, Sections 7285.0 et seq.), the provisions of Article 9.5, Chapter 1, Part 1, Division 3, Title 2 of the Government Code (Government Code Sections 11135 - 11139.5), and the regulations or standards adopted by the awarding State agency to implement such article. Contractor or recipient shall permit access by representatives of the Department of Fair Employment and Housing and the Awarding State agency upon reasonable notice at any time during the normal business hours, but in no case less than 24 hours notice, to such of its books, records, accounts, other sources of information and its facilities as said Department or Agency shall require to ascertain compliance with this clause. Recipient, contractor and its subcontractors shall give written notice of their obligations under this clause to labor organizations with which they have a collective bargaining or other agreement. The Contractor shall include the nondiscrimination and compliance provisions of this clause in all subcontracts to perform work under the contract.

Statement of Compliance. The contractor's signature affixed hereon and dated shall constitute a certification under penalty of perjury under the laws of the State of California that the Contractor has, unless exempted, complied with the nondiscrimination program requirements of Government Code Section 12990 and Title 2, California Code of Regulations, Section 8103.

Performance Evaluation. Contractor's performance under this contract will be evaluated after completion. The evaluation will be filed with the Department of General Services.

Availability of Funds. Work to be performed under this contract is subject to availability of funds through the State's normal budget process.

Audit Clause. The contracting parties shall be subject to the examination and audit of the Auditor General for a period of three years after final payment under the contract. (Government Code Section 10532).

Reimbursement Clause. If applicable, travel and per diem expenses to be reimbursed under this contract shall be at the same rates the State provides for unrepresented employees in accordance with the provisions of Title 2, Chapter 3, of the California Code of Regulations. Contractor's designated headquarters for the purpose of computing such expenses shall be: Nevada City, CA.

NONDISCRIMINATION COMPLIANCE STATEMENT

South Yuba River Citizens League (SYRCL)
COMPANY NAME

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

SHAWN E. GARVEY
OFFICIAL'S NAME

6·28·98
DATE EXECUTED

NEVADA COUNTY
EXECUTED IN THE COUNTY OF

Shawn E. Garvey
PROSPECTIVE CONTRACTOR'S SIGNATURE

EXECUTIVE DIRECTOR
PROSPECTIVE CONTRACTOR'S TITLE

SOUTH YUBA RIVER CITIZENS LEAGUE (SYRCL)
PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME

Attachments

Attachment 1.	Map of Yuba Watershed
Attachment 2:	Ecosystem Restoration Plan Proposal, volume 2, page 273
Attachment 3:	John Williams, Cirriculum vitae Michael Deas, Cirriculum vitae
Attachment 4:	Confirmation of National Fish and Wildlife Foundation grant to pursue this project
Attachment 5:	Agenda and Notes to May 5, 1998 Inter-Agency discussions regarding "Salmon and Steelhead Restoration above Englebright Dam" List of Attendees to May 5, 1998 Inter-Agency meeting
Attachment 6:	Lower Yuba River Investigation, US Fish and Wildlife Service, May 1994
Attachment 7:	Rindge Dam Removal Study, Bureau of Reclamation, April 1995
Attachment 8:	Elwha River Dam Removal Draft EIS, Olympic National Park, April 1996

USDA United States Department of Agriculture

Natural Resources Conservation Service

Grass Valley Service Center
113 Presley Way, Suite 1
Grass Valley, CA 95945
(530)272-3417

July 1, 1998

To: CALFED - Watershed Management

Subject: Proposal - Assessment of the South Yuba River Category III Program

The Proposition 204 Steering Committee for Nevada County at their June 24, 1998 meeting gave a unanimous vote to broaden the scope of the Proposition 204 MOU to accommodate the CALFED objectives. Not only did they vote to support the CALFED proposal, but they also voted to support the long-term project goal of developing a coordinated watershed management and implementation plan for the South Yuba River (Phases II - IV), with input and involvement by the MOU group.

The Yuba River has been one of the most used and abused rivers in the Sierra Nevada. The South Yuba River Citizens League, in cooperation with the Yuba Watershed Restoration Group, is dedicating its efforts to improve conditions in the watershed, and therefore water quality, which will benefit the Bay Delta. Their study will help determine the feasibility of removing Englebright Dam to allow salmon and steelhead access to historical spawning and rearing habitats.

We definitely support this proposal and request your approval.

Ron Zinke

Ron Zinke
District Conservationist and Committee Chair

Attachment

MEMORANDUM OF UNDERSTANDING

Between the

Nevada County Resource Conservation District, County of Nevada, US Forest Service, USDA Natural Resources Conservation Service, California Department of Forestry and Fire Protection, California State Parks, Northern Sierra Air Quality Management District, North San Juan Fire Protection District, Yuba Watershed Institute, South Yuba River Citizens League, City of Nevada City, Bureau of Land Management, Nevada County Superintendent of Schools Office, Friends of Deer Creek.

This Memorandum of Understanding (MOU) is made and entered into between the above signatories.

I. PURPOSE

The purpose of this MOU is to establish a framework upon which the parties may cooperatively plan mutually beneficial work projects and activities envisioned by the State of California Proposition 204, California Water Code, Division 24, Safe, Clean, Reliable Water Supple Act, Article 5, Delta Tributary Watershed Program.

II. INTRODUCTION

WHEREAS, all parties have a mutual interest in developing watershed rehabilitation projects to protect regional water quality and corresponding watershed properties for the public good; and

WHEREAS, all parties have the public responsibility to identify and take corrective actions where water quality may become degraded; and

WHEREAS, all parties administer properties that are eligible for grants provided under the Delta Tributary Watershed Program.

NOW, THEREFORE, in consideration of the above premises, the parties hereto agree as follows:

III. PARTIES AGREE TO

1. Actively pursue opportunities for mutually beneficial work projects or activities that fit under the Delta Tributary Watershed Program.

2. Enter into supplemental agreements or other legal instruments with each other to implement any grant funding received under the auspices of this program.

IV. GENERAL TERMS AND CONDITIONS

1. This agreement is neither a fiscal nor a funds obligation document. Any endeavor involving reimbursement or contribution of funds between the parties to this instrument will be handled in accordance with applicable laws, regulations, and procedures including those for Government procurement. Such endeavors will be outlined in separate agreements that shall be made in writing by representatives of the parties and shall be independently authorized by appropriate statutory authority. This instrument does not give that authority.

2. Modifications within the scope of this instrument shall be made by the issuance of a bilaterally executed modification prior to any changes being performed.

3. This instrument in no way restricts any signatory party from participating in similar activities with other public or private agencies, organizations and individuals.

4. Any signatory party, in writing, may request termination of their participation at any time before the date of expiration.

This instrument is executed as of the last date shown below and will expire on September 30, 2001, at which time it will be subject to review, renewal, or expiration.

Kerry Arnett 12/18/97

Kerry Arnett, President
Nevada County Resource Conservation District

Sam Dardick 1/6/98

~~Rene Antonson~~, Chairman, Sam Dardick
Nevada County Board of Supervisors

John H Skinner 12/19/97

John Skinner, Forest Supervisor
US Forest Service, Tahoe National Forest

Ron Zinke 12-22-97

Ron Zinke, District Conservationist
USDA Natural Resources Conservation Service

12-18-97

Jim Marchio, Unit Chief
California Department of Forestry and Fire Protection

J. Ray Patton, Park Superintendent
California State Parks

12/15/97

Rodney A. Hill, Air Pollution Control Officer -
Northern Sierra Air Quality Management District

12/16/97

Charlotte Killigrew, Chairperson, Board of Directors
North San Juan Fire Protection District

12/17/97

Bob Erickson, President, Yuba Watershed Institute

12/24/97

Roger Hicks, President, Board of Directors
South Yuba River Citizens League

12/17/97

Harry Stewart, Mayor, City of Nevada City

12/21/97

Deane Swickard, Field Manager
Bureau of Land Management

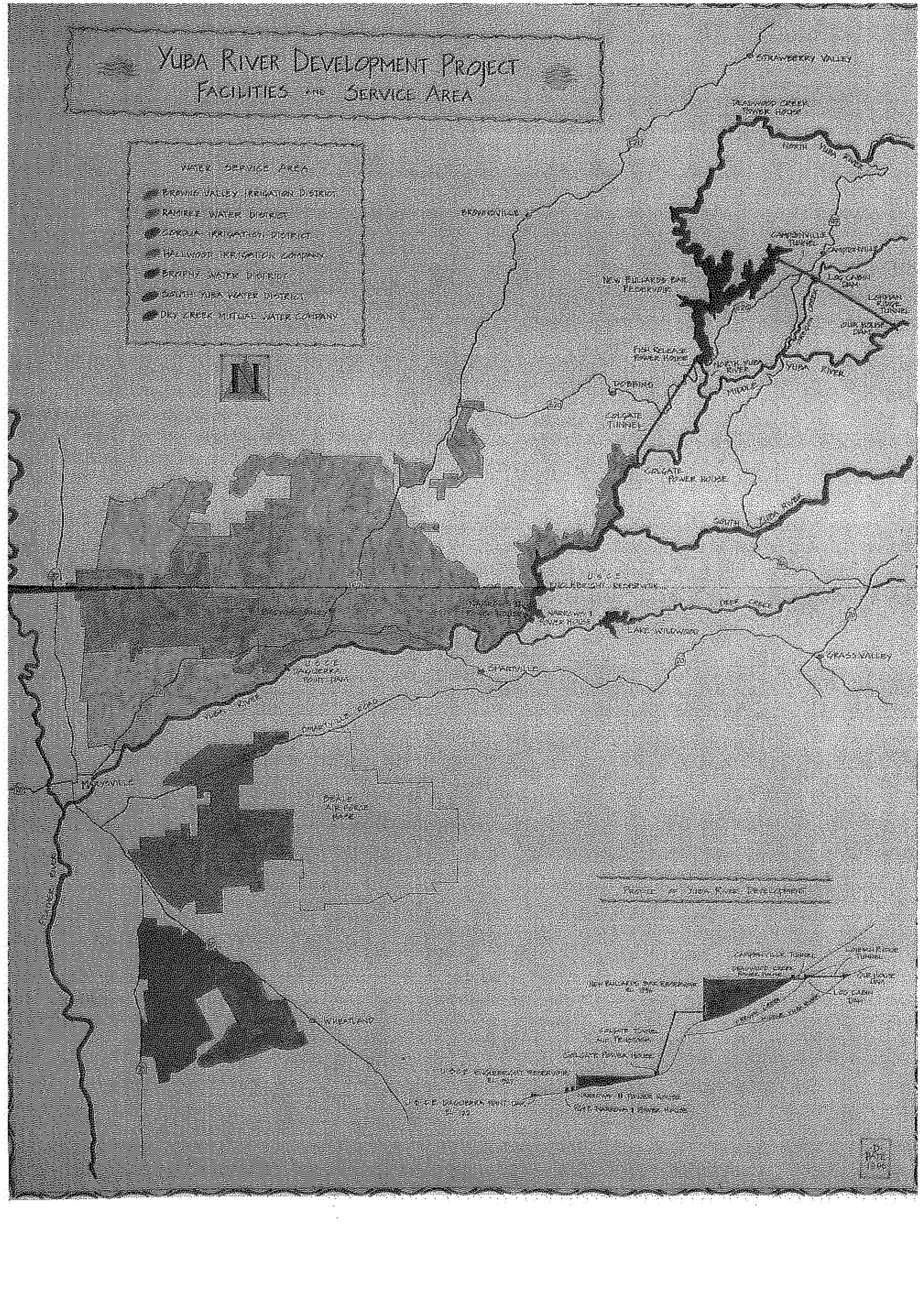
12/18/97

Terence McAteer, Superintendent of Schools, Nevada County

12/16/97

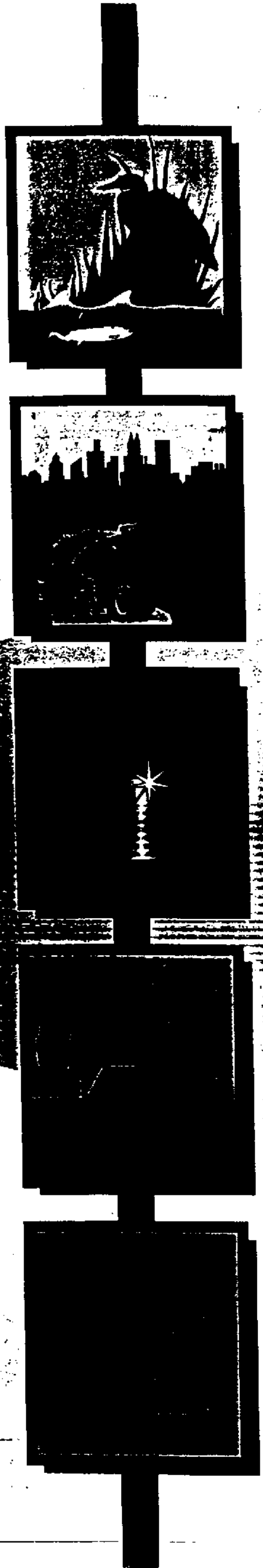
Mary Anne Kreshka, Chairperson, Friends of Deer Creek

Attachment 1: Map of Yuba Watershed



YUBA RIVER DEVELOPMENT PROJECT
FACILITIES AND SERVICE AREA
WATER SERVICE AREA
BROWNS VALLEY IRRIGATION DISTRICT
RAMIREZ WATER DISTRICT
CORDUA IRRIGATION DISTRICT
HALLWOOD IRRIGATION COMPANY
BROPHY WATER DISTRICT
SOUTH YUBA WATER DISTRICT
DRY CREEK MUTUAL WATER COMPANY
N
STRAWBERRY VALLEY
BROWNSVILLE
NORTH YUBA RIVER
CAMPTONVILLE
NEW BULLARDS BAR RESERVOIR
FISH RELEASE POWER HOUSE
DOBBINS
COLGATE TUNNEL
COLGATE POWER HOUSE
YUBA RIVER
LOG CABIN DAM
OUR HOUSE DAM
LAKE WILDWOOD
GRASS VALLEY
MARYSVILLE
YUBA RIVER
WHEATLAND
PROFILE OF YUBA RIVER DEVELOPMENT
COLGATE POWER HOUSE

Attachment 2: Ecosystem Restoration Plan Proposal, Volumne 2, pg. 273



CALFED
BAY-DELTA
PROGRAM

Ecosystem Restoration Program Plan

Volume II

Programmatic EIS/EIR
Technical Appendix
March 1998

Programmatic Action 3a: Develop a cooperative program to evaluate and screen diversions in the Feather River to protect all anadromous fish life stages.

Rationale: Water diversion, storage, and release in the watershed directly affect fish, aquatic organisms, and nutrient levels in the system and indirectly affect habitat, foodweb production, and species abundance and distribution. Unscreened diversions cause direct mortality to young fish; the level of mortality is likely influenced by the number of young fish present, diversion size, and diversion timing.

Dams, Reservoirs, Weirs, and Other Structures

Implementation objective: The implementation objective for dams, reservoirs, weirs, and other structures is to increase the upstream spawning and rearing habitat connection with the mainstem rivers in the Sacramento-San Joaquin basin. This would increase success of adult spawners and survival of juvenile downstream migrants.

Target 1: Increase adult and juvenile anadromous fish passage in the Yuba River by providing access to 100% of the available habitat below Englebright Dam (◆◆◆).

Programmatic Action 1a: Develop a cooperative program to improve anadromous fish passage in the Yuba River by removing dams or constructing fish ladders, providing passage flows, keeping channels open, eliminating predator habitat at instream structures, and constructing improved fish bypasses at diversions.

Programmatic Action 1b: Facilitate passage of spawning adult salmonids in the Yuba River by maintaining appropriate flows through the fish ladders or modifying the fish ladders at diversion dams.

Programmatic Action 1c: Conduct a cooperative study to determine the feasibility of removing Englebright Dam on the Yuba River to allow chinook salmon and steelhead access to historical spawning and rearing habitats.

Target 2: Improve chinook salmon and steelhead passage in the Bear River by providing access to 100% of the available habitat below the SSID diversion dam (◆◆).

Programmatic Action 2a: Improve chinook salmon and steelhead passage in the Bear River by negotiating with landowners to remove or modify culvert crossings on the Bear River.

Rationale: Dams and their associated reservoirs block fish movement, alter water quality, remove fish and wildlife habitat, and alter hydrologic and sediment processes. Other structures may block fish movement or provide habitat or opportunities for predatory fish and wildlife, which could be detrimental to fish species of special concern.

Land Use

Implementation objective: Promote rangeland management practices and livestock stocking levels to maintain high-quality habitat conditions for wildlife, aquatic, and plant communities; protect special-status plants; protect riparian vegetation; maintain shaded riverine aquatic habitat; and prevent bank erosion.

Target 1: Protect, restore, and maintain ecological functions and processes in the Feather, Yuba, and Bear River watershed by eliminating conflicts between land use practices and watershed health (◆).

Programmatic Action 1a: Work with landowners, land management agencies, and hydropower facility operators to protect and restore the watershed.

Programmatic Action 1b: Work with landowners, land management agencies, and hydropower facility operators to increase chinook salmon and steelhead survival in the Feather, Yuba, and Bear Rivers and the Sutter Basin.

Attachment 3:
John Williams, Lead Investigator
Michael Deas, Investigator

John Garrett Williams
Curriculum vitae

Address: 875 Linden Lane, Davis, CA 95616
Telephone: 530-753-7081; fax 530-756-3784; email jgwill@dcn.davis.ca.us

EDUCATION

1978-1979: Postdoctoral Scholar with Dr. Park Nobel, Environmental Biology Section, Laboratory of Nuclear Medicine and Radiation Biology, University of California, Los Angeles.

1978: Ph.D., Geography, University of California, Los Angeles; thesis title: A method for obtaining more climatological information from short observational records.

1966: B.A., History, University of California, Berkeley.

PROFESSIONAL EXPERIENCE

1990-present: Independent consultant

1997-present: Executive Director, San Francisco Bay-Delta Modeling Forum (part time).

1990-1997: Special Master, *Environmental Defense Fund v. East Bay Municipal Utility District.*

1985-1990: Senior Associate, Philip Williams & Associates, Ltd., San Francisco.

1984-1985: Principal, Williams, Kondolf and Swanson, Carmel, California.

1982-1983: Environmental Analyst, Monterey Peninsula Water Management District.

1982: Visiting Professor, Department of Geography, Kent State University, Kent, Ohio.

VOLUNTEER TEACHING

1997: Co-taught a graduate seminar on instream flow issues with Dr. Peter Moyle (WFC 291, spring quarter).

PUBLIC SERVICE

1978-1981: Director, Monterey Peninsula Water Management (elected).

1983-1987: "

1976-1978: Member, Zone 11 Advisory Committee to the Monterey County Flood Control and Water Conservation District (appointed).

OTHER RELEVANT EXPERIENCE

1988-Present: Representative, the Ventana Chapter of the Sierra Club, in State Water Resources Control Board hearings regarding the Carmel River and other water rights proceedings.

1994-1996 Participant, Lower American River Task Force.

1995-1996: Participant, Central Valley Project Improvement Act Restoration Fund Roundtable.

1994-1995: Member, Hydromodification technical advisory committee, State Water Resources Control Board.

OTHER WORK EXPERIENCE

1980-1981: Owner/Manager, Pacific Mushroom Company, San Francisco.

1963-1971: (sporadically): Commercial fisherman, Alaska and California.

PUBLICATIONS

Papers published in refereed journals:

Williams, J.G. 1997. Testing the independence of microhabitat preferences and flow. Comment. *Transactions of the American Fisheries Society* 126:536-537.

Castleberry, D.T., J.J. Cech Jr., D.C. Erman, D. Hankin, M. Healey, G.M. Kondolf, M. Mangel, M. Mohr, P.B. Moyle, J. Nielsen, T.P. Speed, and J.G. Williams. 1996. Uncertainty and instream flow standards. Essay, *Fisheries*:21(8):20-21.

Williams, J.G. 1996. Lost in space: minimum confidence intervals for idealized PHABSIM studies. *Transactions of the American Fisheries Society* 125:458-465.

Kondolf, G.M., L.M. Maloney, and J.G. Williams. 1987. Effects of bank storage and well pumping on base flow, Carmel River, Monterey County, California. *Journal of Hydrology* 91:351-369.

Woodhouse, R.M., P.S. Nobel, and J.G. Williams. 1983. Simulation of plant temperature and water loss by the desert succulent *Agave deserti*. *Oecologia* (Berlin) 57:291-297.

Williams, J.G. 1981. Eigenvector filtering of three-dimensional pressure field data. *Journal of Applied Meteorology* 20:59-65.

Woodhouse, R.M., P.S. Nobel, and J.G. Williams. 1980. Leaf Orientation, radiation interception, and nocturnal acidity increase in the CAM plant, *Agave deserti*. *American Journal of Botany* 63:1179-1185.

Williams, J.G. 1976. Small variation in the photosynthetically active fraction of solar radiation. *Arch. Met. Geoph. Biokl., Ser. B* 24:209-21.

Williams, J.G. 1976. Change in the transmissivity parameter with atmospheric path length. *Journal of Applied Meteorology* 15:1321-1223.

Papers submitted:

Williams, J.G. submitted 1/97, resubmitted 4/98 Stock dynamics and adaptive management of habitat: an evaluation using simulations. *North American Journal of Fisheries Management*.

Williams, J.G., T.P. Speed, and W.F. Forrest. submitted 2/98. Transferability of Habitat Suitability Criteria for fishes in Warmwater Streams. Comment. *North American Journal of Fisheries Management*.

Kondolf, G.M., E.W. Larsen, and J.G. Williams. Ready to be submitted. Measuring and modeling the hydraulic environment for determining instream flows. (To be submitted with other papers from a symposium to *North American Journal of Fisheries Management.)*

Papers published in symposium proceedings:

Williams, J.G. and G. M. Matthews. 1990. Willow ecophysiology: implications for riparian restoration, with G. Matthews. Pages 196-202 *in* Environmental Restoration, J. Berger (ed.) Island Press, Washington, DC.

Kondolf, G.M., P. Vorster, and J.G. Williams. 1990. Hydraulic and channel stability considerations in stream habitat restoration. Pages 214-227 *in* Environmental Restoration, J. Berger, (ed.) Island Press. Washington, DC.

Williams, J.G. 1989. Interpreting physiological data from riparian vegetation: cautions and complications. Pages 381-386 *in* Proceedings of the California Riparian Systems Conference: Protection, Management in the 1990's, Sept. 22-24, 1988, Davis, California. Gen. Tech. Rept. PSW-110, Forest Service, USDA, Berkeley, CA.

Williams, M. and J.G. Williams. 1989. Avifauna and riparian vegetation in Carmel Valley, Monterey County, California. Pages 314-318 *in* Proceedings of the California Riparian Systems Conference: Protection, Management in the 1990's, Sept. 22-24, 1988, Davis, California. Gen. Tech. Rept. PSW-110, Forest Service, USDA, Berkeley, CA.

Williams, J.G. 1983. Habitat change in the Carmel River basin. Pages 5-26 *in* Channel Stability and Fish Habitat, Carmel River, California. Guidebook to symposium and field conference, June 16-18, Monterey, California.

Invited book reviews:

Williams, J.G. 1996. California Water, by A.L. Littleworth and E.L. Garner. Estuaries (Journal of the Estuarine Research Federation) 19:753

Abstracts:

Williams, J.G. and G. Matthews. 1987. The 1983 erosion event on Tularcitos Creek, Monterey County, California, and its aftermath. Proceedings of the California Watershed Management Conference, Nov. 18-20, West Sacramento, Calif. University of California Wildlands Resources Center Report No. 11.

McNeish, C., G. Matthews, and J.G. Williams. 1984. Effects of groundwater pumping on water stress in riparian trees in Carmel Valley, California, With C. McNeish (main author) and G. Matthews. Agronomy Abstracts.

Letters in professional journals:

Fisheries 20(9):38, 1995, regarding the temperature tolerance of juvenile chinook salmon.

Edited works:

Williams, J.G., Ed. Transcript of Workshop on instream flow standards, University of California-Davis, April 7, 1995. Water Resources Center Report No. 89, 1997, Centers for Water and Wildlands Resources, University of California, Davis, CA 95616.

Significant works of limited distribution:

Williams, J.G. Notes on adaptive management. 1997. Prepared for the Ag-Urban Ecosystem Restoration Team.

Williams, J.G. 1995. Report of the Special Master, Environmental Defense Fund v. East Bay Municipal Utility District, Alameda County (California) Action 425955.

MEETINGS AND SYMPOSIA ORGANIZED
River Ecosystems: New Directions and Challenges in Setting Instream Flows. August 1997. Symposium at the 1997 National Meeting of the American Fisheries Society, Monterey, California. (with W. Lifton and S. Williamson.)

Workshop on Instream Flow Standards: April 7, 1995. (sponsored by the Centers for Water and Wildlands Resources, University of California, Davis.) Davis, California.

Biology of the Sacramento-San Joaquin river system: life in the new regulatory environment. June 29, 1993. Special session, joint conference of the Western Association of Fish and Wildlife Agencies and Western Division, American Fisheries Society. Sacramento, California.

Workshop on Central Valley chinook salmon: Jan. 4-5, 1993. (sponsored by UC Davis Dept. of Wildlife and Fisheries Biology, organized with Joe Cech, Peter Moyle, Keith Marine, and Dan Castleberry) Davis, California.

Rivers in the city: design and management in the age of public trust. Nov. 2-3, 1990, at UC Berkeley. (sponsored by the UC Berkeley Dept. of Landscape Architecture, organized with G.M. Kondoff) Berkeley, California.

Politics and practices of restoration: symposium and field tour, Carmel River Watershed. Sponsored by the Watershed Management Council. October 6-7, 1989. (organized with G. Mathias Kondolf, Donna Lindquist, and Bruce Laclergue; a guidebook was prepared). Carmel, California.

Channel stability and fish habitat, Carmel River, California. June 16-18, 1983. (sponsored by CDFG, Packard Foundation, and MPWMD, organized with G.M. Kondolf; a guidebook was prepared). Monterey, California.

INVITED TALKS
Setting instream flows in the face of uncertainty: adaptive management, the precautionary principle, and the public trust. California-Nevada Chapter of the American Fisheries Society, 1998 annual meeting, symposium on stream flow conditions below dams: biology and law. April 23, Sacramento, California.

Setting instream flow standards in large rivers: the American River experience. 1997 National Meeting of the American Fisheries Society, symposium on instream flows. August 27. Monterey, California.

PHABSIM is a broken compass. Northeast Division of the American Fisheries Society, 1997 annual meeting, special session on instream flows. April 28, Framingham, Mass.

OTHER AREAS OF EXPERIENCE
Consulting experience with stream and wetland restoration, fluvial geomorphology, flood management, water rights, and water supply.

VII. Michael L. Deas

Address: 2119 Camino Court, Davis, CA 95616

Telephone: (530) 753 6386 (H)

Email: mjbdeas@jps.net

Education
Ph.D.
University of California, Davis
Year Rec'd: Degree Expected Fall, 1998
Major: Water Quality/Resources
Dissertation: Water quality management of a river-reservoir system - application to the Klamath River, CA

Master of Science
University of California, Davis
Year Rec'd: March 1989
Major: Water Resources
Master's Thesis: A finite element model of groundwater flow on shallow layer and perched aquifers.

Bachelor of Science
University of California, Davis
Year Rec'd: June, 1986
Major: Civil Engineering

Certificates and Licenses:
Registered Professional Civil Engineer, State of California (1990, #C 045624)

Research Experience:

Project Manager, Klamath River water temperature and water quality modeling project. University of California Davis. (United States Fish and Wildlife Service and California State Water Resources Control Board, 205(j) Clean Water Act grant), 6/95 - present.

Application of hydrodynamic and water quality models to analyze water quality control alternatives designed to improve anadromous fisheries in the Klamath River downstream of Iron Gate Dam. Simulated dissolved oxygen, temperature, nutrients, and algal dynamics. In response to alternative timing and quantity of reservoir releases as well as retrofitting outlet works to allow selective withdrawal for downstream temperature control.

Project Manager, Shasta River Flow and Temperature Modeling Project. University of California, Davis. (California State Water Resources Control Board, 205(j) Clean Water Act grant, 3/95 – 6/98.

Project included modeling flow and water temperature on the Shasta River. Subtasks included hydrology, meteorology, water temperature data inventory and woody riparian vegetation inventory. Modeling included examining impact of riparian shading on this small river system.

Project Manager, Sacramento River Temperature Modeling Project. University of California Davis. (California State Water Resources Control Board, 205(j) Clean Water Act grant, 3/95 - 3/97.

Managed a team of engineers to implement and apply computer models to analyze the potential for temperature control in reaches critical for salmon reproduction downstream of Central Valley Project (CVP) reservoirs. Project team completed application of finite difference models of major CVP reservoirs – Lake Shasta and Trinity Lake; and implemented, calibrated, and verified one-dimensional finite element hydrodynamic and water temperature models for Keswick Reservoir, and the Sacramento and Feather Rivers.

Research Engineer, Putah Creek Coarse Sediment Evaluation below Monticello Dam (UC Davis Public Service Research Program), 6/95-8/96

Designed and completed field monitoring program to examine morphological changes to Putah Creek. Field work and associated research revealed that direct effects of Monticello Dam include creek aggradation due to tributary sediment contributions, as well as tributary down-cutting due to reduced post-project stream levels.

Project Manager, Willits Bypass Floodplain Study. University of California, Davis. (California Department of Transportation (CalTrans)), 4/94 - 6/95.

Applied a two-dimensional finite element hydrodynamic model to an inundated floodplain with coalescing streams in Little Lake Valley near Willits, California, to determine flooding impacts of alternative freeway alignments. Verified and applied model for 100-year flood event. Determined bridge opening requirements to maintain backwater effects of less than 1.0 feet, where possible.

Professional Experience:

VIII. Consulting Engineer, Trinity Reservoir Water Temperature Simulation Model, Trinity County, 1/98 – 6/98

Applied computer simulation model Water Quality for River-Reservoir Systems (WQRRS) to Trinity Reservoir. Calibrated and verified WQRRS and applied model to representative carryover storage quantities for assessment of water temperature control alternatives.

Senior Engineer, Earth Science Associates, 1992-93.

Designed, constructed, tested, and applied a monthly operations model of the Los Angeles Department of Water and Power Mono Basin – Owens Valley Aqueduct System (Los Angeles Aqueduct Simulation Model). Implemented a long-term computer model maintenance program. Performed water supply analysis for various clients.

Consulting Engineer, Los Angeles Department of Water and Power - 1991, 1993.

Co-managed Mono Basin – Owens Valley computer modeling project. Formulated and implemented system operation model for Los Angeles' eastern Sierra Nevada water gathering facilities. Participated in a UCLA-Mono Basin public policy program mediation effort, and served on technical advisory committees for the State Water Resources Control Board (State Board) water rights re-issuance hearings for Los Angeles. Testified before the State Board concerning predictive computer models for the Mono Basin and Owens River Basin.

Assistant Engineer, Aqueduct Division, Los Angeles Department of Water and Power, 1989-90.

Revamped and expanded the Mono Basin computer model from a spreadsheet to a FORTRAN program capable of assessing a wide range of scenarios. Conducted various studies examining the impact of alternative operations and hydrologic conditions on Mono Lake surface elevations and water supply to Los Angeles. Reviewed water rights issues and made recommendations to legal staff.

Civil Engineer, Hydrologic Engineering Center, U.S. Army Corps of Engineers, 1987.

Researched and formulated a report on the Corps responsiveness to the 1986 drought in the southeastern United States. The report, titled "Lessons Learned from the 1986 Drought" compiled information learned from the drought and presented specific recommendations for drought contingency planning.

X. Teaching Experience:

Associate-Instructor, Department of Civil and Environmental Engineering, University of California, Davis, Fall, 1997.

Unsteady Flow in Surface Waters (Civil and Environmental Engineering 277) – Instructor for graduate course covering topics of unsteady flow. Subjects included long waves in surface flow, St. Venant equations, method of characteristics, explicit and implicit finite difference methods, stability of numerical schemes, and flood routing techniques.

Teaching Assistant, University of California, Davis, 1986-88, 1993, 1996.

Duties included preparing lectures, designing homework assignments, administering and grading tests, evaluating student performance, and assigning grades. Classes include:

- Engineering 3: Introduction to Engineering (lab)
- Engineering 35: Statics (discussion)
- Civil and Environmental Engineering 10: Introduction to Surveying (lab)
- Civil and Environmental Engineering 141L: Hydraulics (lab)
- Civil and Environmental Engineering 145: Design of Open Channel Structures (class)
- Civil and Environmental Engineering 152: Civil Engineering Planning (class)
- Civil and Environmental Engineering 271: Water Resources Planning Lab (class)

Job Related Honors, Awards, Memberships:

Nonimee: Hugo B. Fisher Award, Bay-Delta Modeling Forum for management of the Sacramento River Temperature Modeling Project, University of California, Davis. February, 1998.

Nominee: Nominated for Sacramento River Watershed Program Public Service Award for management of the Sacramento River Temperature Modeling Project, University of California, Davis. October, 1997.

Mentor: Women in Engineering Link Mentor Program, April - June 1996.

Reviewer: ASCE Journal of the Water Resources Planning and Management Division; Water Resources Research.

Panels/Advisory Committees:

Water Quality Modeling Panel (1998), Klamath River Technical Working Group
Mono Lake Technical Advisory Group (1992-93), State Water Resources Control Board
Mono Lake Public Policy Program (1991); City of Los Angeles, UCLA

Professional Affiliations:

American Society of Civil Engineers
American Water Resources Association
American Geophysical Union

Supplemental Information:

Reports

Deas, M.L., and G.T. Orlob (1998) *Shasta River Hydrodynamic and Temperature Modeling Project Report*. Clean Water Act 205(j) Grant Program, California State Water Resources Control Board and the Shasta Valley Resources Conservation District. June (Final report under review).

Deas, M.L. and G.T. Orlob (1997) *Shasta River Data Inventory*. Clean Water Act 205(j) Grant Program, California State Water Resources Control Board and the Shasta Valley Resources Conservation District. June.

Deas, M.L., J. Haas, and G.T. Orlob (1997) *Shasta River Woody Riparian Vegetation Inventory*. Clean Water Act 205(j) Grant Program, California State Water Resources Control Board and the Shasta Valley Resources Conservation District. June.

Deas, M.L., G. K. Meyer, and C.L. Lowney (1997) *Sacramento River Temperature Modeling Project*. Clean Water Act 205(j) Grant Program, California State Water Resources Control Board and Trinity County Planning Department. January.

Deas, M.L., C.L. Lowney, and R.B. Krone (1996) *Evaluation of Coarse Sediment Sources and Transport in Putah Creek below Monticello Dam - Observations of a Managed Water Resources System*. Public Service Research Program, UC Davis, Bioregion Grant Category A: Natural resources and biological problems in the Putah Creek watershed. August.

King, I.P. and M.L. Deas (1995) *Willits Bypass Floodplain Study*. UC Davis for California Department of Transportation, District 1. Grant No. 01E675.

Los Angeles Aqueduct Simulation Model (1993) Prepared in cooperation with the Los Angeles Department of Water and Power, Aqueduct Division - Operations Section. September.

Coufal, E.L. and M.L. Deas (1990) *Mono Lake Water Balance Model (LADWP90)*. Los Angeles Department of Water and Power, Aqueduct Division - Hydrology Section. June.

Johnson, W.K. and M.L. Deas (1987) "Lessons learned from the 1986 drought." *IWR Policy Study 88-PS-1*, Water Resources Support Center, U.S. Army Corps of Engineers, Fort Belvoir, VA.

B. Proceedings

Deas, M.L. and G.T. Orlob (1997) Iterative calibration of hydrodynamic and water temperature models – application to the Sacramento River." *Proceedings Water for a Changing Global Community.* 27th Congress of the International Association for Hydraulic Research and hosted by the American Society of Civil Engineers Water Resources Division, August 10-15, San Francisco, CA, 1997.

Deas, M.L. and J. Schuyler (1994) "The development and application of a large computer model – an example utilizing the Los Angeles Aqueduct System." *Proceedings, Computers in the Water Industry*, American Water Works Assc., April 10-13, Los Angeles, CA, 1994. pp. 523-534.

Deas, M.L. (1992) "Computer Modeling Responsibilities For Municipalities, Case Study: Water Supply For The City of Los Angeles - Mono Lake, CA." *Proceedings, Water Resources Sessions at Water Forum '92*, M. Karamouz, ed., 338-343, ASCE, New York, NY.

Master's Thesis

Deas, M.L. (1989) *Finite element model of groundwater flow on shallow layer and perched aquifers.* Master of Science Thesis, UC Davis, March.

Presentations and Posters

Deas, M.L. and G.T. Orlob "Sacramento River Temperature Modeling Project: Application Hydrodynamic and Temperature Models." Presented at the American Geophysical Union, Fall Meeting, December 8-12, 1997, San Francisco, California. December 10, 1997.

Deas, M.L. and G.T. Orlob "Sacramento River Temperature Modeling Project: Challenges in Watershed Modeling." Presented at the State of the Watershed Symposium, Sacramento River Watershed Program, California. October 8, 1997.

Deas, M.L. C.L. Lowney, and G.T. Orlob "Sacramento River Temperature Modeling Project." Poster presented at the California Watershed Symposium, Sacramento, California, April 23, 1997.

Deas, M.L. and G.T. Orlob "Application of computer models for assessing temperature control alternatives in the Sacramento River system." Poster presented at the Center for Ecological Health Research annual meeting, University of California, Davis. March 17, 1997.

Deas, M.L. and G.T. Orlob. "Assessment of Alternatives for Flow and Water Quality Control in the Klamath River below Iron Gate Dam." Presented at the Klamath River Restoration Conference in Yreka CA. March 11-13, 1997.

Haas, J., M.L. Deas, and G.T. Orlob. "Preliminary Riparian Vegetation Evaluation for the Shasta River, California." Presented at the Klamath River Restoration Conference in Yreka CA. March 11-13, 1997.

Lowney, C.L., M.L. Deas, and G.T. Orlob. "Longitudinal Temperature Characteristics of the Klamath River below Iron Gate Dam." Presented at the Klamath River Restoration Conference in Yreka, CA. March 11-13, 1997.

Deas, M.L., J.F., DeGeorge, A.E. Bale, and C. Saviz. "Modeling Combined Stresses on Ecosystems." Poster presented at the Center for Ecological Health Research annual meeting, University of California, Davis. March, 1995.

Deas, M.L., J. Schuyler. "The development and application of a large computer model - an example utilizing the Los Angeles Aqueduct System." Presented at Computers in the Water Industry, American Water Works Association, April 10-13, Los Angeles, CA, 1994.

Deas, M.L. "Computer Modeling Responsibilities for Municipalities, Case Study: Water Supply For The City of Los Angeles - Mono Lake, CA." Presented at Water Resources Sessions at Water Forum '92, American Society of Civil Engineers, New York, NY, 1992.

Papers in Submission

King, I.P., and M.L. Deas. Two-dimensional finite element modeling of a broad shallow floodplain. *Journal of Hydraulic Engineering*, American Society of Civil Engineers. January, 1998.

Papers in Preparation

Deas, M.L., G.T. Orlob, and I.P. King. Hydrodynamic and temperature modeling of the Sacramento River System, an application of finite difference and finite element models.

Deas, M.L. and D. Webb. Hydrodynamic properties and design considerations for tube screens used to protect juvenile salmonids.

Attachment 4:
National Fish and Wildlife Foundation Update

SYRCL

SOUTH YUBA RIVER
CITIZENS LEAGUE

June 12, 1998

Mr. Eric Hammerling
Program Director, California Office
National Fish and Wildlife Foundation
116 New Montgomery Street
Suite 203
San Francisco, CA 94105

Dear Eric:

Thank you for your letter of May 15 unofficially confirming a grant of $85,000 ($25,000 NFWF matching funds and $60,000 non-federal challenge funds) for the "Restoring Salmonids to the Yuba River Project" through the California Grassroots Salmon Initiative. This is great news and as you know SYRCL is already working closely with a dozen state and federal agencies, UC Davis and a fisheries biologist to begin implementation of this project.

In brief, I'd like to update you on some of our successes since my letter of April 14:

First and most important, on May 5, 1998 SYRCL convened a meeting with 30 representatives of a dozen state and federal agencies to discuss Upper Yuba River Salmon and Steelhead Restoration at US Forest Service offices in Nevada City, CA. This 4 hour meeting was immensely successful and has lead to further discussions with Fish & Game, Fish and Wildlife, NMFS and UC Davis to formulate a proposal for the CAL-FED Ecosystem Restoration Program. An agenda and list of attendees is attached;

Second, SYRCL has begun the process of community education on the issue of Englebright Dam, which provides no flood control benefits but stops entirely the return of salmon and steelhead to more than 500 miles of the Yuba River and its tributaries. Several news articles have appeared and a Sunday Commentary piece is being prepared. News articles are attached;

Third, SYRCL has been successful in focusing attention on the restoration opportunities on the Yuba to the point that CAL-FED has identified the funding of "a cooperative study to determine the feasibility of removing Englebright Dam on the Yuba River to allow chinook salmon and steelhead access to the historical spawning and rearing habitats. As far as we aware, this is the largest dam removal project proposed by CAL-FED. CAL-FED ERP Action 1C attached;

240 Commercial Street, Suite E
Post Office Box 841
Nevada City, California 95959
916/265-5961 • Fax 916/265-6232

Fourth, SYRCL has been successful in obtaining $35,000 from the Conservation Alliance to pursue this Yuba River Restoration Initiative. This is a signficant portion of the non-federal match and will be sent to NFWF with an affadavit. SYRCL has also been successful in obtaining commitments for the remaining $25,000 match. Also, SYRCL held its annual auction fundraising on June 6 which raised $35,500 towards this effort.

Fifth, SYRCL is working with John Williams and Jeff Mount to prepare additional proposals to submit to CAL-FED to enable additional necessary studies of this proposal. Proposals will be forwarded by mid-July;

Finally, SYRCL is working closely with the Planning and Conservation League as they redirect their salmon studies from the American River to the North Yuba River. The North Yuba River is the site of the New Bullards Bar Dam, which would block salmon and steelhead restoration in the North Yuba. PCL's proposal would take salmon and steelhead as reintroduced to the base of New Bullards Bar via the decommissioning of Englebright Dam for restoration up that historically significant Yuba branch.

Also, as requested you will find the following:

1) A copy of SYRCL's letter confirming 501c(3) status;
2) A copy of our 1996 IRS Form 990. SYRCL has applied for and received an extension for 1997 until September, also enclosed;
3) A copy our financial statements;
4) A budget for SYRCL's "Upper Yuba Salmon and Steelhead Restoration Plan."

Once again, thank you for making this work possible. It is my hope and belief that this work will begin to reap significant rewards in due time.

Sincerely,

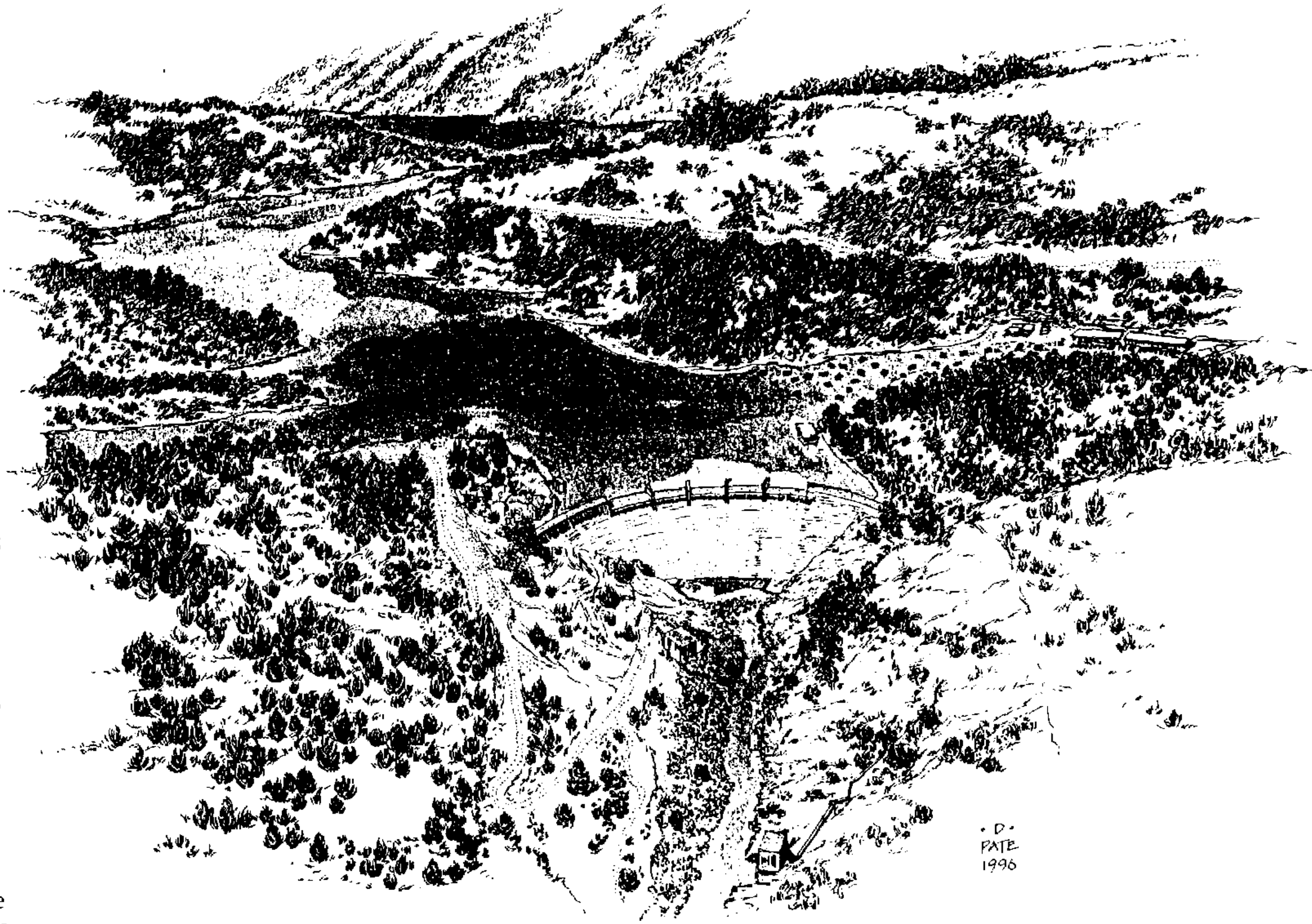
Shawn Garvey
Executive Director

South Yuba

The South Yuba comes to life at 9,000 feet in Placer County near Castle Peak and Donner Lake. As you drive east or west on Interstate 80 between Emigrant Gap and Donner Pass you can catch glimpses of this pristine waterway on its journey to Englebright Reservoir and the main stem of the Yuba River many miles away. Dozens of creeks large and small flow into the South Yuba as it moves downhill through Placer and Nevada Counties to Yuba County near the old townsite of Bridgeport.

A few miles from Bridgeport the South Yuba joins its siblings—the North and the Middle—and flows into Englebright Reservoir, at a location 3.3 miles downstream from the New Colgate Powerhouse.

Englebright Dam, which is about 10 miles downstream of New Colgate Powerhouse, was built in 1941 by the U.S. Army Corps of Engineers. It was designed to keep upstream hydraulic gold mining debris out of the lower parts of the river. But by the time the dam was completed, World War II had put a stop to gold mining. Two tunnels at the dam move water to the turbines that generate electricity in the PG&E owned and operated Narrows 1 Powerhouse and the Yuba County Water Agency owned and operated Narrows 2 Powerhouse. The two powerhouses are located on opposite sides of the river.



U.S.C.E ENGELBRIGHT DAM AND RESERVOIR

Attachment 5:
Agenda and Notes
InterAgency Discussion Regarding
"Salmon and Steelhead Restoration above Englebright Dam"

List of Attendees

May 5, 1998

Inter-Agency Discussions
Upper Yuba River Salmon and Steelhead Restoration

Sponsored by
The South Yuba River Citizens League

May 5, 1998
10:00 AM to 2:00 PM
US Forest Service
631 Coyote Street
Nevada City

Inter-Agency Discussions of Upper Yuba River Salmon and Steelhead Restoration
May 5, 1998 10:00 AM to 2:00 PM
US Forest Service, 631 Coyote Street, Nevada City
Meeting Agenda

10:00 – 10:15	Introductions
10:15 – 10:45	Background about purpose of meeting and need to discuss anadromous fish restoration on upper Yuba river an its tributaries. Fish passage beyond Englebright Dam Catriona Black, SYRCL
10:45 – 11:15	Presentation on a current project to restore salmon runs on the Elwha River in Washington's Olymipic National Park. Brian Winters, National Park Service
	Presentations: Conditions on the Yuba
11:15 – 11:25	Yuba River Fisheries John Nelson, California Department of Fish and Game
11:30 – 11:40	Englebright Dam Operations and Current Conditions Douglas Grothe, Dam Administrator, Army Corps of Engineers
11:40 – 11:50	Salmon Habitat Availability on the Upper Yuba Tributaries Ann Carlson, Tahoe National Forest
11:50 – 12:00	Oppen Discussion: Is anadromous fish restoration on the upper Yuba a goal which agencies would support if a practical and acceptible method could be agreed upon?
12:00 – 12:20	Lunch Break – light lunch provided
	Resume Presentations and Discussion: Restoration Options and Proposals, Agency Cooperation, and Funding Sources
12:20 – 12:40	The CALFED Bay-Delta Program's Ecosystem Restoration Program: Opportunities for restoration plan assistance Sergi & Terry Mills Terry Mills, CALFED
12:40 – 1:00	The CVPIA Anadromous Fish Restoration Program Scott Spaulding, AFRP
1:00 – 2:00	Open Discussion: Questions that should be addressed include: What are the options for practical methods of fish passage? What is the political feasibility? What would be the effects on salmon and steelhead populations? What would be the significance of effects on power production? What are the research and information needs? Is there a need for formal agency coordination? What would be the format? Do we need to hold another meeting to follow up on this?

Restoring anadromous fisheries on the Yuba River above
ENGLEBRIGHT DAM

Executive Summary

Englebright Reservoir has never been used for its original purpose of debris control and provides no flood control benefits, yet has profoundly altered the character of the Yuba by blocking the upstream migration of anadromous fish. But Englebright is a component of basin-wide power production, as it is currently used as a reregulating pool for New Bullard's Bar Dam operations.

Working with agency officials and reviewing government documentation has uncovered a belief that Englebright is not a necessary structure and is providing only minimal benefits. Further, its removal would potentially greatly enhance rare, threatened and endangered anadromous fish populations and provide an excellent recreational resource to the public. Public support is already present in many upstream communities and throughout the state's environmental and fisheries organizations.

The Yuba River System

The Yuba River system is located within the Central Valley of California, draining 1,3339 mi^2 of the western slope of the Sierra Nevada in Sierra, Placer, Yuba and Nevada counties. The Yuba is tributary to the Feather River, which feeds into the Sacramento. From the junction with the Feather at Marysville, California, it is approximately 24 miles to the base of Englebright Dam. As the Dam has no fish passage facilities, this is the limit of anadromous fish migration on the Yuba River system, though historically salmon and steelhead ran to the limits of the watershed up the North, Middle, and South Forks. Even with access to less than 10% of the watershed, the Yuba fisheries are still recognized as "a significant producer of naturally spawned salmon and steelhead." In fact, the Yuba supports one of the last self sustaining steelhead trout fishery and one of the last wild runs of Chinook salmon.

Englebright Dam

At an elevation of 527msl (mean sea level), the 206-foot-high Englebright Dam was completed by the California Debris Commission in 1941 to control the downstream migration of mining debris and silt. The facility is currently operated by the Army Corps of Engineers. Englebright impounds 70,000 acre-feet of water in a reservoir 10 miles long that floods the main stem Yuba River, and the lowest half mile of the South Fork of the Yuba River.

Englebright features two power generation facilities that produce 250 million kWh of energy. The Pacific Gas and Electric Company (PG&E) operates Narrows I Powerhouse on the left bank of the Yuba, just below Englebright Dam (FERC 1403). PG&E also has water rights to 45,000 acre-feet (AF) of storage in Englebright Reservoir plus certain claimed riparian rights. The Yuba County Water Agency (YCWA) has operated Narrows II Powerhouse, on the right bank and some 400 feet downstream of Englebright, since 1970. Narrows II uses regulated releases from New Bullards Bar, via Englebright, for power production.

Most of the water from Englebright Dam is released through the two powerhouses for hydroelectric power generation. Consequently, the 0.2 miles of river between the dam and the powerhouses normally has standing water, except when the reservoir is spilling.

Daguerre Point Dam

Daguerre Point Dam is located 12.5 miles downstream from Englebright Dam and is the major point of water diversion on the lower river. As with Englebright, Daguerre was built by the California Debris Commission in 1906 to reduce downstream migration of mining debris and is currently operated by the Army Corps of Engineers. A fish ladder permits some passage of migrating fish to spawning areas farther upstream, but problems with the ladder limit its usefulness to steelhead and salmon and are blamed for significant fish mortality. Water is diverted by the YCWA at Daguerre Point Dam to serve water districts to the north and south of the Yuba.

The Original Purpose

Englebright and Daguerre dams are simple "spill and fill" dams whose only purpose is to control mining debris. During the California Gold Rush hydraulic mining stripped the Yuba basin and sent millions of cubic yards of debris into the rivers. Repeatedly threatened by mucky, tailings-laden floods, downstream residents filed suit. In 1884 Federal Circuit Court Judge Lorenzo Sawyer dramatically ended hydraulic mining in the Yuba Basin in one of the first environmental rulings in the nation. Construction of Englebright was approved by congress because of the severe reduction in capacity of Feather and Sacramento Rivers caused by the heavy siltation. Congress formed the Debris Commission because this sediment was blocking commercial navigation, and the dams were built to catch what was still coming down. Some sources say that Englebright was built with the intention of resuming hydraulic mining on the Yuba. Resumption was prevented by Congressional legislation which stopped all hydraulic mining on US rivers and streams.

A Corps report in 1990 concluded that Englebright had never been used for debris control since no upstream mining activity had occurred since the dam's construction (The South Yuba 1993, DFG 1991). The dam's impacts on the river are nevertheless considerable and decisive: it alone blocks upstream migration of salmon and steelhead.

Alternative Uses Infeasible

Englebright and Daguerre have no flood control capacities and very limited water storage ability because they have no lower release gates. The hydropower facilities have only limited profit potential.

Improving the facility to provide for more water storage is infeasible. In 1989 a study prepared for the YCWA by Ebasco, Inc, reviewed proposals to raise Englebright Dam to elevation 560 feet msl and retrofit the facility with a bypass. This was deemed uneconomical due to limited power generation and water supply. (Ebasco, 4-4) In its 1977 General Design memo that Corps of Engineers studied raising Englebright to 560 feet msl, creating a total of 100,000 acre-feet of flood storage space, but concluded the project was economically infeasible and would not provide needed flood control. (1977 COE, pg 48)

In its 1990 report on the Yuba River Basin the Corps of Engineers also studied alternate proposals to raise Englebright by 10, 20 and 30 feet and expand the reservoir's flood control space. " Based on seismic studies of Englebright Dam, it was concluded that raising Englebright 20 to 30 feet was infeasible due to the cost of construction needed to ensure seismic stability. Cost estimates and benefit analysis of raising Englebright Dam by 10 feet was also not judged to be economical. (1990 COE, pg. 52)

Recreational Facilities at Englebright Lake

The Army Corps operates recreational facilities at Englebright Lakes including 100 campsites up and down the lake, picnic areas, and boating access facilities. Due to high maintenance costs and low user rates, the park loses money for the Corps every year. Last year was typical of Englebright's annual losses; the Corps spent $752,700 for operation, maintenance and recreational facilities. Their revenues from camping fees and boat launching fees were only $14,980.

Maidu rights?

Potential for Restoration

Decommissioning or severely modifying Englebright dam would be the most remarkable reclamation project in the history of the Sierra Nevada. It would very likely make possible restoration of salmon to half of the Yuba River watershed: all the way to Spaulding Dam on the South Fork, to the base of New Bullards Bar Dam on the North Fork, to Jackson Meadows on the Middle Fork, and to dozens of smaller tributaries along the way. This would be the farthest intrusion of salmon into the Sierra Nevada, and according to a representative from California Sportsfishing Alliance, "the best salmon fishery in the entire state."

In beginning the investigations into this intriguing possibility, we have found that there is a surprising amount of acceptance of this idea among resource agency officials. Personal interviews and document reviews have turned up many references to the lack of purpose for Englebright's continued operation and to the desire to change its management or remove it altogether. These sentiments were found within the Army Corps of Engineers, California State Parks Commission, the Department of Fish and Game, and the CALFED Bay-Delta Program.

The First Step

To begin any investigations into the restoration of salmon and steelhead above Englebright dam, is important to bring together the stakeholders to address several basic questions.

- What are the fisheries resources in the Yuba River Watershed, and what are the limiting factors?
- Is there a need or desire to restore salmon and steelhead to the upper Yuba watershed?
- What are the potential methods?
- What is the process to achieve mutual restoration goals?

The purpose of this meeting of federal and state resource agency officials is to initiate a discussion about the agencies perspective on the these questions. Representatives from several agencies will present their findings and concerns related to the condition of the Yuba River or the potential for restoration above Englebright Dam. We expect to have a lot of difficult questions brought up, and we will challenge the appropriate agencies and interest groups to develop answers or research strategies. The following may help to initiate discussion on each of the important questions listed above.

What are the fisheries resources in the Yuba River Watershed?

The California Department of Fish and Game reports that the Yuba River supports populations of fall-run chinook salmon and steelhead in the remaining habitat on the lower Yuba River, and that there are also reports of salmon exhibiting spring-run chinook characteristics.

"California Department of Fish and Game (DFG) and US Fish and Wildlife studies show that 95% of California's historic salmon and steelhead habitat has been lost (Fisher 1997). In response to this habitat loss, the state's salmon and steelhead populations have dwindled to only 35-40% and 20%, respectively, of their historic numbers (Anonymous 1982, Fisher 1979)." (DFG 1991) Realizing the value of these resources, California, under the Salmon, Steelhead and Anadromous Fisheries Program Act (1988) requires the DFG to develop a plan and program that strives to double the current natural production of salmon and steelhead resources. The CVPIA has a similar mandate.

Because the DFG recognizes the Yuba "as a significant producer of naturally spawned salmon and steelhead," they are targeting it as a potential location for enhancing naturally spawning populations. The DFG conducted a three-year study on the fisheries of the Lower Yuba River. In their 1991 report, they made several remarks that indicate a need to change the management of Englebright Dam to meet their goals. The following are examples:

- "Habitat for fry and juvenile salmon and steelhead is currently less than optimum. Channel narrowing and degradation have reduced available habitat for these life stages." (DFG 1991)
- "Spawning gravel conditions within the Yuba River are generally excellent. However, in the upstream area no new recruitment of gravel can occur due to the presence of Englebright Dam." (DFG 1991)

Is there a need or desire to restore salmon and steelhead to the upper Yuba watershed?

This issue has been addressed by state and federal agencies for many decades. The listing of salmon and steel head populations as endangered indicates without question the urgent need to protect and restore these populations. Already, there are several efforts by several agencies and coalitions to protect and enhance them in their current habitat below the dam.

The question for this group then becomes: Is it enough to simply protect the remaining stocks in their current, limited range? Or, is it necessary for their ultimate survival to expand current populations and restore access to former habitat? Several State and Federal Agencies are sponsoring programs to do the latter.

An example effort in salmon and steelhead recovery on the Yuba is the CALFED Draft Ecosystem Restoration Program Plan, which specifically targets the Yuba river system for protection and enhancement of anadromous fish populations. Listed Programmatic Actions Include purchasing streambank conservation easements, improving screening of diversion points, and "Develop a cooperative program to improve anadromous fish survival in the Yuba River by removing dams or constructing fish ladders, providing passage flows, keeping channels open, eliminating predator habitat at instream structures, and constructing improved fish bypasses at diversions." (ERPP, vol. II, pg 253) Also to "Facilitate passage of spawning adult salmonids in the Yuba River by maintaining appropriate flows through the fish ladders or modifying the fish ladders at diversion dams." (ERPP, vol. II, pg 253)

Also listed among ERPP Programmatic Actions is the intention to "Work with landowners, land management agencies, and hydropower facility operators to increase chinook salmon and steelhead survival in the Feather, Yuba, and Bear Rivers and the Sutter Basin." (ERPP, vol. II, pg 254, emphasis added).

Another significant listed actions is to "Increase adult and juvenile anadromous fish survival in the Yuba River by providing access to 100% of the available habitat below Englebright Dam." (ERPP, vol. II, pg 253) This would require modification of hydropower releases since they cause a slack water pool for .2 miles between the dam and the first powerhouse.

What are the potential methods?

There are several potential methods that might be considered for restoration of habitat or passage beyond the dam. Each of these would require substantial research to determine feasibility, desirability, and potential consequences. Options that might be considered are listed below.

- Removing the dam.
- Fish ladders (maybe feasible in conjunction with lowering or otherwise modifying the dam)
- Operation of a "dry dam" at the Narrows site, (reservoir is empty and river flows freely past dam except during flood events)
- Others?

What is the process to achieve mutual restoration goals?

If it was agreed upon that there exists a reasonable interest in pursuing anadromous fish restoration above Englebright Dam, what would the next steps be? Some possible options are listed below.

- Form a group to direct and coordinate efforts to research options and their potential costs and benefits.
- Pursue funding for research and organization efforts.
- Call meetings with more representatives from a broader range of the stakeholders not represented here to discuss the basic questions and get a broader perspective on the need or desirability for restoration efforts.

The South Yuba River Citizens League

SYRCL's mission is to protect and restore the Yuba River and the related ecosystem. SYRCL will continue to research the Englebright and Daguerre Point Dams for possible decommissioning or alteration, and will continue to build public support for this important mission. We believe that if the public is satisfied that an adequate flood control program is put into place for the communities of Yuba City and Marysville, and that removal or alteration of these dams will not add to the risk of flood damage, there will be strong public support for changed management through relicensing.

It is very exciting to suddenly be in an era when people can talk rationally about the possibility of removing harmful dams that provide little benefit without being written off as extremists. In this atmosphere, a situation like the one on the Yuba, where a dam seen by many as useless is blocking one of the states last good salmon runs, dam removal actually has a chance. This chance is dependant on coordinated efforts of all stakeholders who share the same vision of a restored Yuba River, a river once again producing abundant and healthy salmon stocks.

SYRCL is looking forward to working with all of the involved agencies, public interest groups, and other local stakeholders in our efforts to protect and restore the Yuba River and to provide for public access and enjoyment of this vital and inspiring public resource.

For more information contact:
Catriona Black, Director, Yuba River Protection and Restoration Campaign (916) 372-0686
The South Yuba River Citizens League (530) 265-5961

References
(Ebasco, 4-4) "Limited Reconnaissance Flood Project Study of Yuba River Basin" Ebasco Services, Incorporated / Yuba County Water Agency May 1989

(1977 COE, pg 48) "Draft Feasibility Reports and Appendixes, Yuba River Basin, California" US Army Corps of Engineers October 1997 " Environmental Impact Report"

"Lower Yuba River Fisheries Management Plan" California Department of Fish and Game February 1991

"Yuba River Basin Investigation, California, Reconnaissance Report" Army Corps of Engineers March 1990

The Charlotte Observer

River runs free

The dam's removal will benefit fish

The Quaker Neck was no towering Hoover Dam, but for 45 years it might as well have been for the beleaguered striped bass, shad and shortnose sturgeon.

The wall of concrete, a mere seven feet tall, proved a mighty monument to birth control for fish in the Neuse River. The fish couldn't get around it. Their populations plummeted when they couldn't complete their journey from the sea to their spawning grounds upriver. Striped bass catches fell from 740,000 pounds annually in the early 1970s to less than 100,000 pounds in the 1980s. American shad catches fell from 8 million pounds a century ago to about a quarter million pounds in recent years. The little dam has been called a major impediment to restoring Neuse fisheries.

Enter sledgehammers and a wrecking ball — and U.S. Interior Secretary Bruce Babbitt leading the charge. Quaker Neck will go down in history as the first U.S. dam to be destroyed for environmental reasons. With whacks of the hammers and a wrecking ball wallop, the demolition began on Dec. 17.

"It's an act of removal," Mr. Babbitt said, "but it's really an act of restoration and renewal."

It's also an act of beneficence on the part of Carolina Power & Light. The company built the dam in 1952 to supply cooling water to a steam plant. But the company came to see the greater environmental benefits of restoring native fish breeding grounds. As a part of the demolition, the government will build a weir to supply the company's water demand.

The December demolition marked another important moment for public-private coalitions working for the public good. CP&L, private conservationists and government officials cooperated to make the demolition possible.

"Up till now, everything that's been done to get the Neuse fixed has been confrontational," Rick Dove, the Neuse River Foundation's river keeper, said.

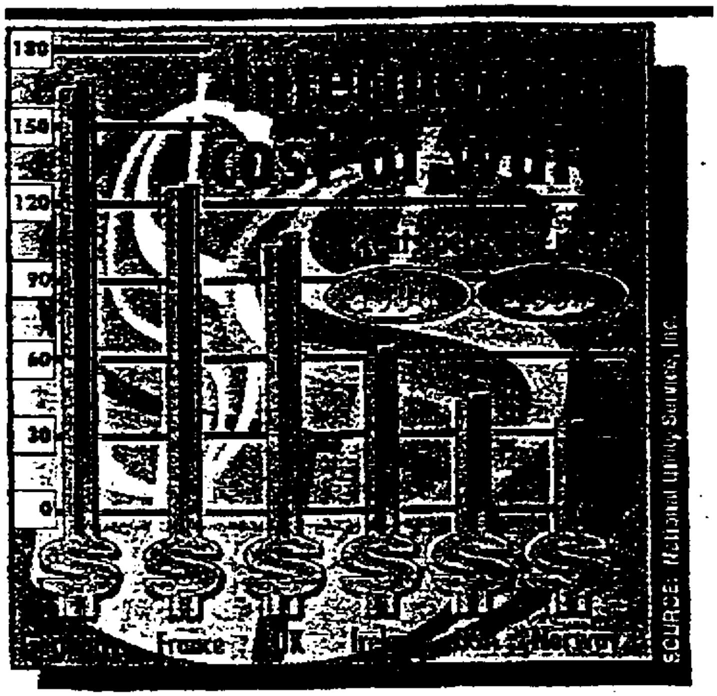
This project was about cooperation, vision and a respect for the past. Quaker Neck made history this month, and the fish got lucky.

February, 1998 US Water News

Some dams come down as river restoration gains momentum

PORT ANGELES, Wash. — For the past 50 years, the U.S. has been on a dam-building spree which, so far, is unmatched by any in human history.

Approximately 75,000 dams now alter the natural flow of U.S. rivers. Although no one is advocating their wholesale removal, many observers believe some of these structures have clearly proven too costly to maintain — or rebuild, in the case of many older dams — given all the impacts dams are now known to have on river ecosystems.



Recent research points to extensive damming as the single most important factor in the dramatic decline of fish species — particularly of anadromous fish, like salmon. Many salmon species are already listed as endangered or threatened in the lower 48 states, where a generation ago spectacular runs were still common.

Biologists have known for some time that dams prevent fish from reaching upstream spawning grounds. Only recently — in the past 10 years or so — have they discovered the full extent of the problem.

Not only do dams prevent fish from reaching their spawning grounds, they transform the very nature of the river, eliminating much of the vegetation that provides cover for juvenile fish, as well as the nutrients that sustain them, according to biologists.

Please turn to Page 4

Water Supply

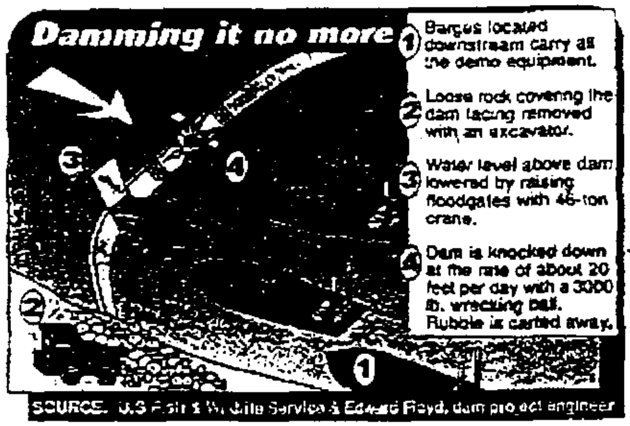
Dams are removed as river restoration gains momentum...

Continued from Page 1

When a dam is built, the entire food chain is altered. Dams trap sediment that would have been deposited downstream. As a result, water sweeping over the dam scours away the river bed. Deprived of both the vegetation and sediment needed to survive, the river's natural microorganisms disappear. Invading fish displace native species.

Even the lack of a natural flood cycle also has a severe impact on river ecosystems. These floods, it has been found, both clear away unwanted debris, and renew fish habitat by creating sandbars, and providing adjacent riparian and wetland ecosystems with water they need to survive.

Faced with the mounting cost of repairing and maintaining aging dams, taxpayers have joined environmental groups and state and federal agencies, in launching detailed



cost/benefit analyses that have brought an about-face in policy on several dams across the country.

At the heart of this change is a 1986 law which requires the U.S. energy commission to take environmental damage into account when it relicenses a dam.

Three dams — one in Maine, one in North Carolina, and one in Washington state — are now authorized for removal. But these decisions have not come without considerable controversy.

Mark Isaacson, vice president of Miller Hydropower Co., which owns Edwards Dam, in Maine, says he will appeal the commission's decision, because the commission can order dam removals at the owner's expense.

Meanwhile, dam removal is being applauded by many fishermen. In 1996 a semi-collapsed dam on Vermont's Clyde River was removed. Local guide David Smith reports that this September he caught six brook trout more than a foot long in the Clyde, in a place where brook trout hadn't lived for the last 40 years.

The removal of the Quaker Neck Dam on North Carolina's Neuse River began in December 1997 — a demolition which will give striped bass and American shad, among other fish, access to 75 miles of river between the Quaker Neck and the next dam upstream.

But the dam slated for removal on the Elwha River in Washington state may offer the clearest picture — pro and con — of what is at stake in the river restoration process.

After years of study of the precipitous decline in lower Elwha salmon runs — the river has historically supported some 10 species of native anadromous fish, including 7 species of salmon — removal of the Elwha Dam was authorized in 1992. But Congress has yet to authorize the necessary funds to carry out the order.

U.S. Senator Slade Gordon (R), a long-time opponent of removing Elwah river dams, has recently reversed his position, but not without stipulations that many fear would hamper restoration efforts.

According to Michael Q. Langland, director of the River Restoration program for the lower Elwha Klallam Tribe, since the Elwha Dam was built in the early 1900s, there has been only 4.9 miles of free-flowing river between the dam and the river's mouth.

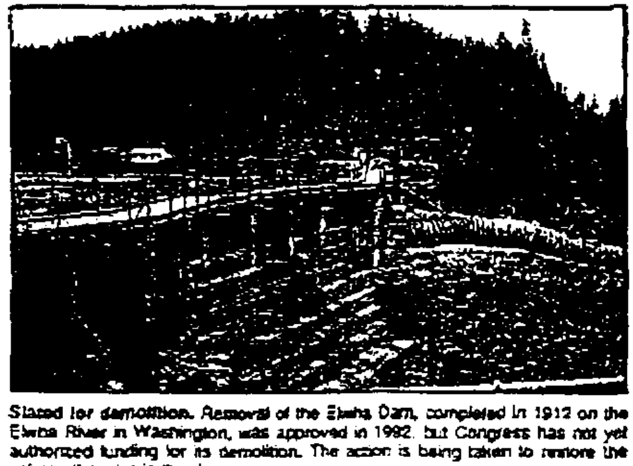
The dam has deprived the salmon both of passage, and the sand and gravel needed for spawning, he said. The reservoir above the dam has also created a "solar heat sink," he added, which warms the water and deprives fish of oxygen, stressing them and making them susceptible to disease.

Both the Elwah Dam and the one above it, the Glines Canyon Dam, were created to supply electricity to the Olympic Peninsula, but "all that has come and gone," said Langland. "The dams are now supplying electricity to one mill — and only 38 percent of that." Restoring the river to its natural condition, he said, makes sense economically, as well as ecologically.

Doug Williams, spokesman for the Hood Canal Strait of Juan de Fuca Northwest Indian Fisheries agrees. Support for dam removal has grown, he said, as this has become more apparent.

"We have a unique opportunity to restore what was once a phenomenal ecosystem," he said. Because the river flows out of glacial areas still protected by Olympic National Park, he explained, the Elwha is naturally cold and pristine.

Williams said that the Elwha is one of the few rivers in the lower 48 states that supported all the major Pacific salmon species. The potential exists,



Slated for demolition. Removal of the Elwha Dam, completed in 1912 on the Elwha River in Washington, was approved in 1992. but Congress has not yet authorized funding for its demolition. The action is being taken to restore the salmon fisheries in the river.

he said, for restoring a salmon run — of all species — as great as 300,000 a year. "This habitat could be very productive," he said.

"Removing this dam makes sense," he said. "We have solid scientific data — and the economic data — to prove it." Furthermore, he said, this river restoration will be studied across the country by others facing the same dilemma.

"Many people are fearful of this trend," he added, "But they also fear losing the salmon. We have found from experience that hatchery production doesn't cut it. We can't mimic nature as we once thought we could. We have so many salmon populations on life-support. The genetic pool is there. We need to be willing to let nature do the job." *Mary DeSena*

Los Alamos Labs studying effect of asteroid impacts on Earth

LOS ALAMOS, N.M. (AP) — Los Alamos National Laboratory researchers say an asteroid hitting an ocean would spawn tsunamis — huge, fast-moving tidal waves — that could devastate entire coastlines.

Los Alamos astrophysicist Jack Hills and his colleague Charles Mader used comparative historical data from tsunamis to come up with a detailed computer simulation. Hills presented the findings at a meeting of the American Astronomical Society in Washington, D.C.

The lab is funding the pair for three years to develop computer models. They expect increasingly sophisticated models to predict more extensive coastal damage than previously calculated.

Hills said an impact from a smaller asteroid could be prevented, and he'd like research to come up with a practical defense plan.

For an asteroid to be deflected, it would have to be spotted, then a nuclear-armed rocket would have to be ready to intercept it. Hills said a nuclear blast in space could shatter or redirect an incoming asteroid. But currently, there is no surveillance or defense capability.

"It's a problem that could be solved for much less than the cost of one hurricane," he said. "We could just set it up and be done with it."

The lab's computer model shows an asteroid impact would induce a series of giant waves that could scour thousands of miles of coastline with walls of water and debris. The model estimated an asteroid 3 miles across hitting in the mid-Atlantic would produce a tsunami that would swamp the entire upper East Coast to the Appalachian Mountains.

Long Island, Delaware, Maryland and Virginia would be inundated. The coasts of France and Portugal also would be drowned.

Scientists say Earth is likely to be hit by an object that large only once every 10 million years. But a relatively small asteroid could strike once in every few thousand years.

The Earth's atmosphere has little effect on objects larger than 600 feet across, so they reach the surface at nearly full velocity, causing a crater on land or under water.

A relatively small object near the Tunguska River in central Siberia in 1908 never even hit the ground, but the shock wave flattened 800 square miles of forest. Los Alamos said such an impact occurs over land an average of every 300 years.

Researchers say most of the damage from an asteroid impact generally would come from tsunamis, which retain their destructive energy while traveling enormous distances.

Such giant waves run up on a coastline, causing widespread damage. When a tsunami strikes the continental shelf, its speed decreases but its height increases.

Last year, Sandia National Laboratories in Albuquerque demonstrated a similar destructive scenario. Sandia impact physicists David Crawford and Mark Boslough studied what would happen if Earth were hit by a comet the size of the Shoemaker-Levy comet that hit Jupiter.

Their three-dimensional supercomputer study showed the impact causing tidal waves and leaving the Earth in a nuclear winter-like state that would wipe out agriculture and kill a billion people.

Taking Down Bad Dams

by Patrick McCully

Dams do not live forever. A dead or dying dam may have silted up, stopped producing electricity, or become increasingly unsafe, at which point it may be a candidate for decommissioning or removal. Not all dams slated for removal are targeted for safety reasons, however: another major reason prompting river activists to call for the removal of dams is the decimation of fisheries.

Although dams have been found unsafe or destructive of fish habitat in many parts of the world, virtually no large dams have yet been removed. The engineering of dam removal is still young and untried, and the cost of dam-removal is still ignored when construction costs are estimated and projects budgeted. How exactly to dismantle a very large dam, what to do with the sediment clogging the reservoir behind it, and how much such an operation would cost are all largely unknowns. Removing a hydrodam could cost even more than building one, especially where reservoir sediments contain heavy metals and other toxic contaminants.

But momentum is building to remove more dams, and to find the best ways to take them down and restore the rivers they impounded. Dam decommissioning campaigns can now be found in many parts of the world, some of which target large dams (see page 10). Currently, the United States – with some 74,000 dams, most of which are relatively small – has perhaps the most active dam-removal movement. Grassroots groups around the country have launched campaigns to dismantle dams in their communities, and hundreds of small- and medium-sized dams have already come down (see story, opposite page). Another sign of progress is that the American Society of Civil Engineers just published technical guidelines for dam removal – the first important sign that the dam-building industry is beginning to take this issue seriously.

Dam decommissioning is defined as anything from merely stopping electricity generation to the expensive and challenging operation of totally removing a dam and restoring the river to its pre-dam state. Decommissioning has in recent years been forced onto the agenda of an unwilling hydropower industry in the US. More than 500 of the 50-year licenses given by the US Federal Energy Regulatory Commission (FERC) to private hydrodam operators are expiring between 1989 and 2004 (see box, opposite page). A coalition of river conservation groups have used this spate of expiring licenses to urge FERC to institute a comprehensive dam decommissioning policy. The Washington, DC-based Hydropower Reform Coalition believes that new licenses should only be given on the condition that owners pay into special decommissioning funds during the lifetime of their projects, just as nuclear power plant operators in the US have to put money aside to pay their inevitable decommissioning costs. Despite strong opposition from the hydropower lobby, FERC announced in late 1994 that it has authority to order owners of the more than 1,800 dams under its jurisdiction to decommission dams which fail to win new licenses, although it has not yet conceded the coalition's call for it to require payments into decommissioning funds.

Old Dams

Safety is the most common reason for dam removals. Dams age at different rates and in different ways, depending on a variety of circumstances. Some dams may remain safe for a thousand years, while others may start to crack and leak after less than a decade.

Around the world, some 5,000 large dams (defined by the industry as being at least 15 meters high) are now more than 50 years old, and the number and size of the dams reaching their half century is rapidly increasing. The average age of dams in the US is now around 40 years. Between 1977 and 1982 the Army Corps of Engineers inspected 8,800 non-federal dams in the US, most of them privately-owned, which it classified as "high-hazard" – where a failure could cause significant loss of life. One-third of these dams were considered "unsafe," primarily because of inadequate spillway capacity. A 1994 survey showed at least 1,800 non-federal dams were still unsafe. The situation is similar for federal dams: in 1987 one-fifth of BuRec's 275 dams were classified as unsafe, as were one-third of the 554 dams operated by the Corps of Engineers.

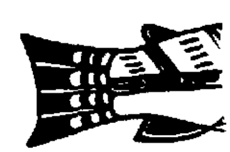
An Ontario Hydro study of data from several hundred North American dams shows that on average hydrodam operating costs rise dramatically after around 25-35 years of operation due to the increasing need for repairs. When the cost of maintaining an old dam exceeds the receipts from power sales, its owners must decide either to invest in rehabilitating the dam or, if the cost of repairs would be prohibitive, to disconnect the dam from the grid and cease producing power.

Many old dams in the US have simply been abandoned by their owners. According to the Michigan Department of Natural Resources (MDNR), several abandoned small dams have been washed out during storms in recent years. "These failures," says the MDNR, "have caused extreme erosion, excessive sediment deposition and destruction of aquatic habitat accompanied by the loss of the fisheries." Michigan taxpayers, through the MDNR, have had to pay for removing several "retired" hydroelectric projects, while their former owners have suffered no financial liabilities.

Fish-Killing Dams

One of the largest dams to be removed in the US to date is the 19-meter (62-foot) Grangeville Dam on Idaho's Clearwater River, which was dynamited in 1963 to restore salmon runs.

Special Focus:



This dam and hundreds like it have decimated productive fisheries in the western states in this century. The Pacific Northwest has been particularly hard-hit. In the huge Columbia River Basin – which covers an area larger than France – the annual run of adult salmon and steelhead trout is estimated to have averaged between 10 and 16 million fish before non-native settlers arrived in the 19th century. Today, after decades of decline due overwhelmingly to the 130 or so dams in the basin, only some 1.5 million salmon and steelhead enter the Columbia each year, and around three quarters of these are hatchery-reared fish. The National Marine Fisheries Service estimated the cost of salmon fishery losses due to dams in the Columbia Basin to be $6.5 billion for the period 1960-80 alone.

While most adult salmon swimming upstream can negotiate their way up fish ladders, the slack water of reservoirs provides a much more formidable barrier to their offspring. The downstream migration of juvenile salmon (smolts) can be fatally delayed by the time needed to drift and swim through multiple reservoirs – if the smolts do not reach the sea within around 15 days after spawning they may lose their down-

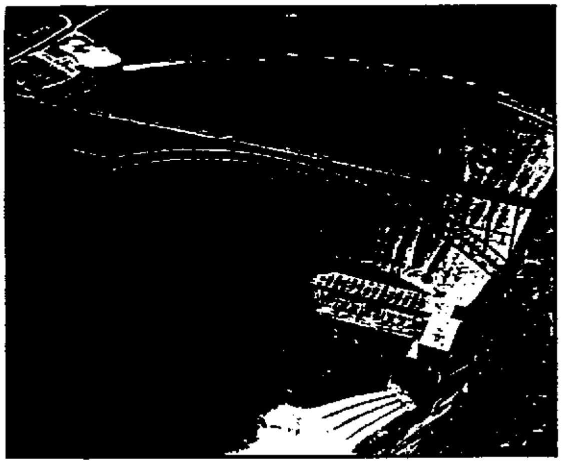
continued on page 14

Decommissioning continued from page 8
stream swimming behavior and their ability to change from a freshwater to saltwater environment. During years of low flows, smolts from the upper Snake River, the Columbia's main tributary, can now take up to 39 days to swim to the sea, compared with less than three days before the dams were built.

Restoring the Elwha

The best-known dam decommissioning controversy surrounds a pair of dams that have decimated fisheries on the Elwha River in Washington state. Built in the 1910s and '20s with a combined installed capacity of 19 megawatts, the dams all but wiped out the river's once-rich runs of steelhead trout and salmon, fisheries to which the Elwha S'Klallam Tribe had been guaranteed rights "in perpetuity" in the remarkably aptly named 1855 Treaty of Point No Point. Power from the two dams (now within the borders of Olympic National Park) is devoted entirely to supplying a pulp and paper mill. Since the Glines Canyon Dam FERC license came up for renewal in the late 1970s, the Lower Elwha S'Klallam and environmentalists have been trying to get the dams removed. In 1992 their long campaign started to bear fruit when Congress directed the Interior Department to detail the best plan for "full restoration of the Elwha River ecosystem and the native anadromous fisheries." The Interior Department concluded that only removing the dams could fully restore the ecosystem.

Removing both dams and dealing with the 11.5 million cubic meters of sediment which has built up behind them is estimated to cost $113 million and take up to 20 years. The dams would be taken down after the river had been diverted around them. Removing the sediment would be the biggest problem and is planned to be done with a combination of dredging, allowing the newly free-flowing river to wash the sediments downstream, and stabilizing with vegetation the sediments higher up the river banks. Removing the Elwha dams enjoys cross-party support in the nation's capitol, but has powerful opponents that have been able to delay funding for the project. However, there is legal impetus to take action: an Act of Congress in 1992 ordered the restoration of the river's fish stocks. ■



Glen Canyon Dam. Computer-generated graffiti by IRN.

Let A River Run Through It

Dave Wegner is a ecological scientist specializing in the restoration of river systems in the West and throughout the world. He has lived in the shadow of the Glen Canyon Dam for 14 years, studying the dam's effects on the downstream ecosystem for the Bureau of Reclamation. His work on last year's experimental flood release from the dam taught him there is much good to be gained from appropriate dam management – but also that such experiments are just a drop in the bucket for the restoration of seriously impacted riverine ecosystems. He is now involved in a new effort to drain the dam's reservoir and restore the Colorado River and its canyons to their former glory. Here Wegner writes passionately about why this river, why now.

An Effort to Restore the Colorado River and Glen Canyon Gathers Steam

The developed Colorado River watershed supports over forty dams, several transbasin diversions and numerous irrigation siphons. This infrastructure has helped the Southwest become one of the fastest growing areas of the United States. Las Vegas alone grows at a rate of more than 4,000 people a month. Many of these new desert residents have water-wasteful lifestyles more appropriate to the wetter climates of the east coast or south.

The price for such development has been steep. Today a disjointed, fragmented Colorado River system, which bears little resemblance to the historic river, supports more houseboats, jet skis and ski boats than it does native fish species. Artificially created reservoirs have drowned thousands of Native American artifacts and with them the cultural heritage of the ancient peoples who lived along the Colorado River and respected it for the life it provided. The changes to the ecosystem have meant lost riparian zones, increased water quality problems, and a crippled Colorado River delta whose fisheries have been devastated by the river's diminished flow and reduced sediment load.

Rivers of Life

Rivers have been crucibles of evolution, the pathways of colonization and sources of inspiration. Rivers are continually balancing themselves in a symphony of movement that results in a complex and dynamic equilibrium supporting a natural web of life. As the Colorado River evolved over the last 20 million years, so, too, did a unique assemblage of native fish, plants and cultures. But when the gates of the 216-meter Glen Canyon Dam closed in March 1963, the waters of Lake Powell quickly began to fill the canyons and transform the riverine environment. Greatly reduced water movement, entrapment of sediments, and modified water quality changed the character of the water resource. The Grand Canyon immediately began to feel the effects of the constrained and modified river, much like a human whose flow of blood from the heart is restricted. In June 1980, 17 years after storage began, the waters of Lake Powell reached the top of the dam and the reservoir was full. From the Bureau of Reclamation's perspective a great triumph had been achieved. To the fish, birds and Native Americans who lived with the river, it was a dark day.

Dams have limited life spans, both structurally and economically. When a dam has lived its useful physical and economic life, become an ecological burden or completed its original objective, it is time to make restoration of the river a priority, and pursue decommissioning of the dam. Today we are at that point with Glen Canyon Dam.

Last October a symposium was held in Utah to raise these issues in a public forum. At the meeting, David Brower, former executive director of the Sierra Club, and representatives of the Glen Canyon Institute challenged the audience to support a move to drain Lake Powell. The response from the 1,600 people in attendance was resoundingly positive. Next came a national resolution from the Sierra Club to support the effort. The "Drain Lake Powell" campaign was launched – a movement born not out of spite but out of a sense of purpose and hope that we as a society could take a step forward and re-evaluate our past actions to determine if we are on the right track for the future.

The Time is Ripe

So why now? We are at a critical crossroads with the Colorado River and Glen Canyon Dam. First, the precedent-setting Environmental Impact Statement on the operations of Glen Canyon Dam was completed in 1995. That EIS sets the stage – in fact demands – that additional innovative approaches to ecosystem maintenance and restoration be evaluated as the scientific knowledge of the ecosystem improved. The EIS established an Adaptive Management program to integrate new findings about the ecosystem's response into management of the dam. Secondly, the native fish and bird species are at a threshold, and if actions are not taken quickly, their future survival may be in peril. Lastly, the political winds have shifted. California, Nevada and Arizona are now searching for additional water sources and new ways to manage the river that balances the needs of the ecosystem with the need for water for human uses.

This shift provides a window of opportunity to evaluate the overall management of the Colorado River, one that seriously looks at alternative approaches to protect the environment and restore lost ecosystem processes.

Unprecedented Restoration

The Glen Canyon effort will be the largest restoration project ever undertaken in the world. It will be a slow process – it could take more than ten years to drain the reservoir, and years more for sensitive ecosystem components to reach a natural balance. It is intended that the dam itself will remain intact as an icon to the past, with the river flowing freely around it.

After the initial draining, water and sediment would be seasonally transported around the dam to replenish the Grand Canyon's ecosystem. Sediment deposits in the upper end of Lake Powell would slowly slump down to river level and onward to the Sea of Cortez where they will replenish downstream ecosystems. Restoration on this magnitude has not been attempted before. The scientific knowledge gained from draining Lake Powell would be applied to other

continued on opposite page

Loire Dams to be Dismantled for Salmon

by Marie Arnould

Before the dams were built, before the onslaught of industrial pollution, before overfishing took its toll, approximately 100,000 Atlantic salmon would make the annual journey to their spawning grounds in the headwaters of France's Loire River and its tributaries. After traveling an amazing 4,000 miles from Greenland in the North Atlantic ocean, they would swim upriver to spawn in the river's clear waters.

In 1996, only 67 salmon were counted on the upper Allier River, the sole tributary in the Loire basin where salmon still return to spawn. As with the Colombia River in the United States, dams were the main cause for the spectacular drop in the salmon population. Young smolts swimming downstream to the ocean get lost in the slack waters of the reservoirs or chopped up in turbines or pumps; adults swimming upstream are foiled by dam walls or inadequate fish ladders. Numerous dams in the Loire basin have destroyed habitat and blocked the fish from their spawning grounds.

Atlantic salmon have completely disappeared from all large rivers on the European Atlantic coast: the Rhine, the Thames, the Elbe, and others. This makes the tiny Loire stock a precious genetic pool for reintroducing salmon in other European rivers. The Loire salmon are also a potent symbol of the "last wild river in Europe." Their plight helped spur the "Loire Vivante" campaign, which arose to stop construction of four new dams in the Loire basin and defend the last remnant salmon populations. The government reacted in 1994, by canceling the largest planned dam (Serre de la Fare), postponing another, reducing the size of a third and devising a program to save the remaining salmon of the Loire basin. The fourth dam, although still officially on the books, may die from lack of funds.

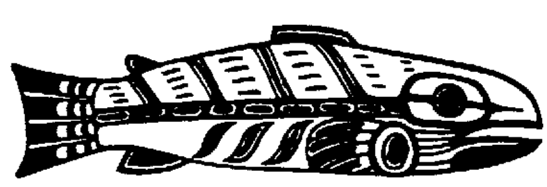
Perhaps the most amazing part of the program (and a first for France) is that two dams will be destroyed in an effort to restore salmon habitat: the Saint-Etienne-du-Vigan on the Upper Allier and the Maisons-Rouges on the Vienne River. Both are operated by Electricité de France, the French state-owned electricity utility. Located near the sources of the Allier River, Saint-Etienne-du-Vigan sterilized 70 acres of the basin's best salmon spawning grounds. Before this 44-foot-high dam was built, the surrounding villages produced approximately 10 tons of salmon per year, which contributed heavily to the local economy. The dam produced just 35 megawatts per year, a tiny fraction of the nation's electrical output.

Preliminary studies have found that the reservoir can be emptied when a flood of about 2,800 cubic feet per second (80 cubic meters/sec.) occurs, which will wash out the accumulated silt in the reservoir and minimize damage on the ecosystem downstream. Everything is now ready for this precedent-setting operation, which will be technically challenging even though the reservoir is relatively small and the sediments not too polluted. It is expected to be finished in 1998 and cost US$60,000.

In spite of the importance to salmon populations of removing the Maisons-Rouges Dam, political opposition on the local level has slowed the process. However, the new French government seems intent on quickly scheduling a timetable for taking down this 15-foot-high hydroelectric dam which destroyed the Vienne river basin's entire 1,900 acres of spawning grounds.

Other measures are planned for saving the Loire basin's salmon, including construction of a hatchery on the Upper Allier, suspension of all fishing and elimination of other obstacles to salmon migration. The goal of the program is to have 6,000 adults return to the Loire estuary in 10 years. But the dream of the groups trying to save the Loire salmon is to have this magnificent fish come back on the Upper Loire. To fulfill this dream, two large dams would have to be dismantled: Villerest and Grangent, both about 200 feet high. And that's quite another kettle of fish! ■

Special Focus: Dam Decommissioning



The author is with European Rivers Network. For more information, visit the group's web site: www.rivernet.org.

Glen Canyon continued

dam-impacted rivers around the world.

The Glen Canyon Institute is initiating a Citizens Environmental Assessment to evaluate the effects of draining Lake Powell by diverting the river around Glen Canyon Dam. The objective is to take the finished proposal to Congress and the Department of the Interior. Once the data on lost water, species and cultures are fully documented, the government will be asked to move forward with administrative action for the draining of Lake Powell. The American people will have an opportunity to voice their opinions on this issue.

There are many hurdles that need to be negotiated to make the restoration of Glen Canyon come true. Detailed analyses of the hydrology, economics, recreation, cultural and environmental issues will need to be accomplished. Funding for this program will come from private citizens and concerned interest groups. We will deal directly with the issues of concern in the preparation and public review of the Citizens Environmental Assessment on draining Lake Powell. An opportunity to publicly debate and develop a restoration project of this magnitude provides the ability for people to work cooperatively towards the future.

Rivers follow their chosen paths with fortitude but are forever adapting to the environment that defines them. Throughout history, rivers have carved canyons, developed and maintained fertile floodplains, created deltas – and supported life. Today in the United States, we must decide if we will continue on the path of overallocation and use of this river for unsustainable development, or take a bold and innovative step forward to restore it to health. It would be a great credit to our civilization to return the Colorado River to Glen Canyon. ■

Dave Wegner is vice president of the Glen Canyon Institute, which was created in 1995 to facilitate the discussion and study of the return of the Colorado River to Glen Canyon through the draining of Lake Powell. For more information, call the institute at (801) 322-0064 or visit its website: www.glencanyon.org. Wegner previously wrote about the Glen Canyon Dam's artificial flood experiment in the July 1996 issue of WRR. *That article can be found on IRN's web site: www.irn.org.*

COMMENTARY Deconstructing Dams

In early April, the US Army Corps of Engineers – one of the country's two major dam building agencies – quietly issued a request to civil engineering firms for a construction bid. Unlike hundreds of other bid requests it had sent out over the past 60 years, most of which signaled the start of another dam and the destruction of another river, this one represented a turning point for the agency and new hope for rivers around the country. The project being bid was the construction of a "fish passage corridor" – essentially, a free-flowing river through the middle of the partially complete Elk Creek Dam.

Construction of the 25-meter-high Elk Creek Dam had been stopped in 1987 by a vigorous campaign led by the Oregon Natural Resources Council. At the time it was stopped, the dam was already 40 percent complete and $100 million had been spent. Not content with merely stopping the dam, ONRC next initiated the campaign to remove the Elk Creek Dam, followed in 1994 by its "damnable dam" campaign to remove 12 existing dams from the rivers of Oregon.

Across the US in the last few years, activist groups like ONRC and many others have gotten bolder and bolder with campaigns urging the removal of ever-larger dams. They argue that rivers should not remain constrained by obsolete river engineering works, most of which were planned in ignorance and deception many years ago and require massive continued public subsidies. California, for example, last year approved $1 billion to be spent on habitat restoration over the next decade to attempt to remedy some of the ecologic impacts of the state's aging reservoir system.

Within the past year, activists have started to organize to allow the Colorado River to run through the massive Glen Canyon Dam (see page 10), and have waged campaigns to remove the Elwha, Savage Rapids and Snake River dams. Whereas only five years ago such initiatives would have been dismissed as hopelessly impractical, public attitudes appear to be changing as the true costs of dammed rivers become apparent.

It seems that people are now starting to better understand the value and complexity of our river systems and how they are disrupted by the continued presence and operation of a dam and its reservoir. At IRN we have noticed a subtle change in the way journalists ask us questions. Before, it was always "Why are you against this dam?" Now we are asked, "Would you support this dam being decommissioned?"

It is no big surprise that just like the nuclear-power lobby, the dam builders like to act as if there is no tomorrow, taking the profits and glory now, and leaving it to future generations to pay the bills. In its 70-year history, the International Commission on Large Dams – the major industry professional organization – has yet to offer dam decommissioning as a topic at one of its international conferences.

Yet the decommissioning of large dams is inevitable – it is only a question of when. Whether decommissioning is due to inevitable aging processes such as reservoir siltation or concrete deterioration, or whether it is done to restore a river, the fact remains that we will be shooting in the dark when it comes to taking down the big ones. The best way to engineer, manage and pay for such projects has yet to be fully examined by the industry that put our rivers behind walls in the first place. These questions are already facing us, with the silting up of 30-year-old dams like Tarbela on the Indus River or Sanmenxia on China's Yellow River. To date, the industry response has been predictable: build another dam to solve the problems of the first. Examples of such projects are the planned construction of the Kalabagh Dam on Pakistan's Indus River and China's Xiaolangdi Dam, projects which pass the buck to future generations.

There is another way. Instead of accepting the inevitability of large dams being built or the permanence of their presence, it is possible to start planning now for more sophisticated long-term and sustainable river management. The starting point of such planning would be to fairly and fully compare the economic, social and ecologic costs and benefits of managing a river in a more natural way, one which meets the needs of the larger community, with the costs over time of building, maintaining, repairing and replacing obsolete large dams. These issues will be the dam fights of the 21st century.

Philip Williams

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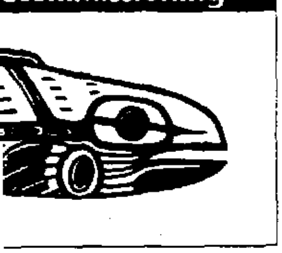
US Dam Removals Documented

by Shawn Cantrell

A new report documenting hundreds of dam removals across the United States will be released this fall by Friends of the Earth (FoE). The report contains a state-by-state listing of known dam removals, as well as detailed case studies of several completed removals. It also outlines pertinent issues which should be considered in a decision about whether to remove or retain a dam. The report provides policy makers and concerned citizens valuable information regarding past dam removals as they consider the future of dams in their own communities.

The report shows that safety concerns have been the most frequent reason cited for dam removals in the US. Related to safety issues are economic concerns: it is often cheaper to remove an aging dam than to invest in necessary maintenance and repairs.

ecommissioning



One of the many hazardous-dam-removal stories described in the new report is that of Two-Mile Dam on the Santa Fe River in New Mexico, demolished in 1994. In 1993, a crack was found in the wall of the 85-foot-high earthfill water-supply dam. Then a new fault line was discovered near its base. Public opposition to the dam removal was great, but the state engineer ordered an emergency removal once the full extent of the safety concerns was realized. Removal took five weeks, and revealed serious structural problems caused by leakage through the crack. The municipal water supply is now stored in two upstream dams, and the former reservoir has been revegetated with wheat grass. A small 5-acre pond remains, providing habitat for ducks and other animals. The cost for the dam removal (including site restoration) was $3.2 million, and was covered by a slight rate increase for the Sangre de Cristo Water Company.

The report also documents several instances in which environmental restoration was a major factor in the decision to remove a dam. In a particularly constrained area of the Columbia and Snake river basins, a startling 95 percent of juvenile salmon fall victim to dam turbines or to the alien conditions of reservoirs behind eight large federal dams. One example of a habitat-restoration removal described in the report is that of Idaho's Lewiston Dam. The small blast that helped bring down the 45-foot-high hydroelectric dam in 1972 prompted Idaho Governor Cecil Andrus to comment, "for me, the [explosion] is a large one, for it symbolized ... that the main stem of the Clearwater River will always be free of dams." The dam removal improved the lot of migrating salmon and steelhead, and restored four miles of free-flowing river. Today, numerous dam-removal campaigns to restore salmon runs have sprung up in the Columbia and Snake river basins.

FoE's research found that dam removal has not been restricted to a particular type of dam, size of structure, or region of the country. Hydroelectric dams, municipal water supply dams, flood control dams, irrigation dams and mining dams have all been removed. While the majority of the historic removals have been smaller structures, dams over 75 feet high have been taken out. The report found information on dam removals in every part of the United States, from New Mexico to Wisconsin to Washington state.

The Federal Energy Regulatory Commission (FERC) has recently recognized that it has the authority to order the decommissioning and removal of dams. FERC has utilized this new-found authority in the case of the Newport #11 Dam, on the Clyde River in Vermont, removed in 1996. Other federal agencies such as the National Park Service have also taken the lead in the removal of outdated dams, including an unsafe dam in Colorado's Rocky Mountain National Park (described in detail in the report). In addition, numerous state agencies and private dam owners have removed dams under their jurisdiction or control.

There are more than 74,000 dams listed in the 1993-1994 National Inventory of Dams, which includes all dams that are at least 25 feet high or hold more than 50 acre-feet of water, and thousands of smaller dams on rivers and streams around the country. Removal has moved to the forefront in several river restoration efforts around the country. The Elwha, Glines Canyon, Edwards, Condit, Savage Rapids, and four federal dams on the lower Snake River are all under consideration for removal, primarily to restore fisheries and avoid further extinctions of dwindling salmon stocks.

As the case studies in this report demonstrate, dam removal is a well-established response for dealing with unsafe, unwanted, uneconomic or obsolete dams. The decision to remove a dam is not as "radical" an idea as some opponents might imply: dams have been removed countless times, for a wide variety of reasons, and under many different conditions. It is important to recognize that dams cannot and should not last forever. Dam removal is a necessary responsibility we have to our rivers and watersheds. ■

For a copy of the report, contact Friends of the Earth's Northwest office at (206) 633-1661.

New Resource on Relicensing

The Hydropower Reform Coalition has just released "Relicensing Toolkit: Guidelines for Effective Participation in the FERC Relicensing Process." The process of relicensing dams by the Federal Energy Regulatory Commission (FERC) has only recently become a major tool for river conservation and restoration. But because FERC's relicensing procedures are complex, it can be difficult for parties less experienced with the process to participate effectively.

The Coalition hopes that this "Tool Kit" will provide some assistance to groups and individuals as they seek to influence how a FERC dam will be operated.

The Hydropower Reform Coalition was formed in 1992 to take advantage of the once-in-a-lifetime opportunity to restore river ecosystems presented by the FERC relicensing process, and to reform the way FERC licenses all hydropower dams. Through the relicensing process, the Hydropower Reform Coalition has made progress in restoring rivers impacted by dams, and has made FERC take seriously its legal obligation to give equal consideration to power and non-power river resources (such as fish, wildlife and recreation) when reviewing hydropower applications.

To get a copy of the Toolkit or for more information contact:

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FROM THE PRESIDENT

A Tremendous Victory for Rivers

Last year will go down in history as the end of the dam era in this country. For the first time ever, the federal government has ordered removal of a hydropower dam whose operation the owner sought to continue, despite its severe environmental impacts.

On November 25, the owner of the Edwards Dam, which has blocked the Kennebec River in Augusta, Maine, for 160 years, was denied a new operating license. The company was ordered to dismantle the dam to reopen habitat and spawning grounds to migratory fish like Atlantic salmon and American shad.

This is a tremendous victory for rivers. The federal government, which grants licenses to operate private dams on public waterways, has finally recognized that the power produced by some dams — while enriching their owners — is worth far less to us as a society than the value of the river as a natural resource.

For American Rivers, this moment is especially gratifying. Over the last 25 years, we have fought on many fronts to prevent dams from destroying our few remaining wild and near-pristine rivers. And it's been a long haul. The Edwards Dam victory alone was the result of a decade-long battle waged by many local and national groups, including American Rivers, the Atlantic Salmon Federation, Natural Resources Council of Maine, and Trout Unlimited.

Now many dammed rivers will reap the benefits of our efforts. The federal government's demand to shut down the Edwards Dam will not only restore the Kennebec River, it will open the door to removing other dams across the country that for years have blocked rivers and destroyed fish and wildlife habitats while generating little amounts of power. Up to this point, dam owners received blanket approval to keep dams operating whatever the costs to rivers. No more. Now, if a dam causes environmental damage that cannot be reversed or reduced, it could actually be removed.

But equally important, the federal government's move shows that Americans are beginning to reconnect with their rivers. This decision clearly reflects the growing public desire to reclaim the waterways and return them to their natural state.

We believe the days of automatic "byes" for dams and dam owners are over. We look forward to a time when more of us can experience first-hand the beauty and abundance of rivers, and we intend to continue our challenges to these river-damaging dams. We hope you will join us.

Rebecca R. Wodder

American Rivers

Winter 1998

American Rivers, founded in 1973, is North America's leading river-saving organization. Our mission is to protect and restore America's river systems and to foster a river stewardship ethic. *American Rivers* is published quarterly to inform and educate members, friends, and the general public about river conservation issues.

There are many ways to support American Rivers' conservation efforts. Membership begins at $20 for individuals ($15 for students and senior citizens) and includes a year of American Rivers' newsletter. Additional contributions —including stocks, property, and bequests — are gratefully accepted. Contributions are tax-deductible to the extent provided by law, with the exception of $3.00, which is allocated for *American Rivers* newsletter.

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Cover: The headwaters of the White Salmon National Wild and Scenic River at Mt. Adams in Washington state. Photo: Tim Palmer

Attachment 6:
Lower Yuba River Investigation
US Fish and Wildlife Service
May '94

UNITED STATES DEPARTMENT OF INTERIOR
FISH AND WILDLIFE SERVICE

RESTORATION REPORT

LOWER YUBA RIVER INVESTIGATION, CALIFORNIA

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SUMMARY

The Yuba River ecosystem supports a rich fish community, which includes the last large and naturally-reproducing (without hatchery supplementation) fall-run of chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento River system. Fisheries on the lower Yuba River--from Englebright Dam to its mouth at the Feather River--face a number of threats. Several problems occur at or near the Daguerre Point debris dam, and provide opportunities to restore populations of anadromous fishes. These problems include: (1) the dam as an impediment to upstream passage of adult salmon, steelhead (*Oncorhynchus mykiss*), and American shad (*Alosa sapidissima*); (2) passage of juvenile salmonids going downstream past the dam, including losses into irrigation diversions associated with the dam; and (3) losses of juvenile and adult salmon into a dewatering channel which enters the river from the Yuba Goldfields. A final long-term threat to salmonids is a decline in the quantity and quality of spawning and rearing habitats in the lower Yuba River.

A stepwise restoration schedule is proposed. The restoration schedule includes immediate restoration measures to (1) improve passage through fish ladders, and (2) prevent juvenile salmonids from entering water diversions at and near Daguerre Point Dam. A final early action is to evaluate and choose long-term restoration actions. The following long-term restoration measures have been identified:

- remove Daguerre Point Dam, and replace existing diversion structures with diversions having minimum impact on fisheries
- modify or replace the fish ladders at Daguerre Point Dam with ladders which provide efficient passage over the range of river flows commonly occurring in the river, especially when adult salmonids are migrating
- replace existing fish screens with structures placed within the river channel, and which incorporate features to minimize juvenile losses to predation, entrainment, and physical injury
- modify the dam spillway to maximize fish ladder efficiency, and to minimize adult and juvenile passage problems
- enhance spawning and rearing habitat, including placing appropriate gravel below Englebright Dam to compensate for blockage of gravel recruitment.

The Fish and Wildlife Service strongly recommends that the Corps of Engineers remove Daguerre Point Dam, because this action above all will truly *restore* the river ecosystem, while offering the greatest benefits to the fish and wildlife which rely on the river. Removing the dam would provide a simple, maintenance-free, and lasting solution to many problems associated with the dam. Should dam removal not be pursued at this time, biological studies should be conducted to identify which other long-term restoration measures would most benefit fish populations. The last step in the restorative process is to select, implement, and monitor one or more long-term restoration measures.

Finally, the Yuba River presents an opportunity for private and public agencies to act cooperatively for the benefit of the river's biological resources, and for the public good. A long stride along that pathway would be to resolve problems associated with Daguerre Point Dam.

INTRODUCTION

This study by the U.S. Fish and Wildlife Service (Service) identifies fish and wildlife restoration opportunities along the lower Yuba River--the reach between Englebright Dam and the Yuba's confluence with the Feather River (Figure 1). The study was requested by the U.S. Army Corps of Engineers (Corps), as a part of the Yuba River Basin Investigation feasibility studies. The Yuba River is very important to anadromous fisheries: it supports a wild run of fall chinook salmon in California's Central Valley, which historically contributed up to 15% of the fall run in the Sacramento River system. The fall run population is significant both for its size and for being "wild"--i.e., self-maintaining without the presence of a hatchery on the river.

The resources of the Yuba River have been described and documented elsewhere, and the reader is directed to existing studies for detailed information on the resources and resource issues surrounding the Yuba River (primary sources are: CDFG 1991; USFWS 1993; COE 1990; SWRCB 1991; and sources cited therein). Previous biological reports on the Yuba River include studies of the impacts of Marysville Dam and other proposed flood-control measures (USFWS 1990, 1993; Wooster and Wickwire 1970), a study of fisheries problems in the Yuba Goldfields and the South Yuba-Brophy diversion (Smith 1990), and a report on the effect of hydraulic mining debris and debris dams on fisheries (Sumner and Osgood 1939). California Department of Fish and Game (CDFG) has prepared a fisheries management plan for the lower Yuba (CDFG 1991), and has also conducted short studies of fish losses at diversions (Hall 1979; Kano 1987; Konnoff 1988); CDFG also conducts annual censuses of fall-run of chinook salmon. RCE (1993) and the Corps (1990) describe the hydrology and geomorphology of the lower Yuba River, especially with respect to flood control, and Jones and Stokes and Associates has studied fisheries.

The Yuba River supports a diverse fish community, with 28 species of resident and anadromous fish reported from the river (CDFG 1991). Three anadromous species attract the most attention because they support substantial commercial and/or sports fisheries. Fall-run chinook salmon are considered the most important species because of commercial and recreational values. The estimated number of fall-run salmon returning to spawn in the Yuba averaged about 12,300 fish between the years 1969 and 1989 (range: 3,800-39,000; s.d.: 8,400; CDFG 1991); recent runs have been below average (1992: 6,000; 1993: 6,345). A second salmonid, steelhead trout, is less numerous, but supports a recreational fishery; because steelhead juveniles spend 1 or more years in the river before migrating to sea, they are sensitive to summer water temperatures and flows. The third anadromous species is American shad, an introduced sports fish whose numbers in the Yuba have declined recently. Spring-run chinook salmon also occur in the Yuba, but it is not known whether the population is self-sustaining, or is maintained by strays from a hatchery on the nearby Feather River. Some spring-run fish produced at the Feather River hatchery are known to stray into the Yuba. The viability of spring-run chinook in the Sacramento River system and elsewhere is of great concern to many biologists and to the fishing industry, with perhaps as few as 1,000 or so wild adults return to the Sacramento system annually. Spring-run chinook salmon are not protected under the Endangered Species Act at the present time.

This study focuses on fisheries problems at and near Daguerre (or Daguerra) Point Dam in the lower Yuba River. A number of significant challenges to Yuba River fish populations are not addressed in this report. These problems are detailed in the Lower Yuba River Fisheries Management Plan (CDFG 1991), and include: decreased stream flows; increased water temperatures as a result of decreased flows; rapid or short-term variation in stream flow, which strands fish and fish nests; water quality; and need for coordination between the agencies using water for diversion and power generation--including Pacific Gas and Electric (PG&E) and the Yuba County Water Agency (YCWA). Flow requirements are critical for fish and other biota, and are the topic of an ongoing case before the State Water Resources Control Board (SWRCB).

Geographical, Hydrological and Historical Setting

The Yuba River drains about 1,340 square miles of the western slope of the Sierra Nevada. The fourth largest of the Sacramento River's tributaries, it has an average annual unimpaired runoff of about 2.4 million acre-feet. It flows into the Feather River near Marysville, which in turn is a major tributary of the Sacramento River. The reach including Daguerre Point Dam and vicinity is characterized by a gradient of about 0.20 percent, with alternating pools, runs and riffles. The river flows through a broad flood plain dominated by gravel and cobble debris which is the result of hydraulic and dredge-mining for placer gold; a notable feature is the Yuba Goldfields--a vast area of dredge ponds and piles. The river has an intermittent fringe of riparian vegetation dominated by cottonwoods (*Populus fremontii*), willows (*Salix* spp.), alders (*Alnus* sp., sycamores (*Platanus racemosa*), blackberries (*Rubus* spp.) and other riparian species. Flanking the river are gently rolling hills covered with grasslands and open stands of oaks (*Quercus* spp.) and gray pines (*Pinus sabiniana*) (USFWS 1993; CDFG 1991; COE 1990; RCE 1993). Steep-sided sediment rows have been built parallel to much of the lower river.

The Yuba River has been altered by humans repeatedly during recent history (summarized in Appendix B). Principal activities have included: (a) hydraulic mining and dredge mining for gold (Sumner and Osgood 1939); (b) construction of dams with associated flow regulation and barriers to fish movements; (c) water diversions, primarily for agriculture, from March through October; and (d) flow regulation for hydroelectric generation.

The most prominent human-made feature in the study area is Daguerre Point Dam, built in 1903-1906 by the California Debris Commission to contain hydraulic mining debris; this debris created flooding, navigational, and other problems from the Yuba River downstream to San Francisco Bay. The dam filled with sediment within 20 to 30 years of completion, and currently has only a shallow (generally less than 15 feet) pool extending about 200 to 300 feet upstream of the dam, and covering about 3 to 4 acres at flows of about 1,000 cubic feet of water per second (cfs). The dam serves no flood control purpose (Operation and Maintenance Manual, Daguerre Point Dam, Army Corps of Engineers).

The dam consists of a concrete ogee spillway, with sloping concrete apron and vertical concrete training walls perpendicular to the dam on each bank. The dam is 24 feet high from crest of its concrete spillway to the apron on the downstream side of the dam; the spillway section itself is 575 feet long. The dam is bordered by concrete abutments and earth-fill non-overflow sections.

Fish ladders are currently located on the north and south banks, on the landward side of the concrete training walls; the dam has a history of long periods with inadequate or no fish ladders (Appendix B). Three water diversion facilities are at or near Daguerre Point Dam, supplying water for irrigation, mainly of orchards, rice, and pastures. The rights to diverted waters is complex, and is administered by the YCWA, an umbrella agency serving many water users. Herein, diversions will be referred to by the names in common use:

- Hallwood-Cordua canal diverts water at the upstream surface of dam, on the north bank. A maximum of about 650 cfs are diverted during the irrigation season, which runs from April through October (SWRCB 1991). CDFG operates a fish screen during the period when the number of fall-run chinook juveniles migrating downstream is at a peak. The fish screen is located in the canal about 1,500 feet from the dam; the screen is a fixed V-shaped type, of perforated sheet metal.
- South Yuba-Brophy system diverts water through an excavated channel from the Yuba's south bank about 1,000 feet upstream of Daguerre Point Dam. Diverted water infiltrates through a porous dike (gabion) designed to exclude fish; the 450 foot-long dike is constructed of a wire-mesh basket filled with rocks. The diverted water then flows by gravity through a transport system which uses excavated canals and pre-existing gold-dredge ponds, while some water bypasses the dike and returns to the river at the dam via an excavated channel. By agreement with CDFG, at least 10 percent of the water diverted from the Yuba River must bypass the gabion structure to allow migrant fish entering the diversion to return to the river. Ten percent bypass flow has not always been met (Smith 1990). A maximum of about 350 cfs has been diverted into the South Yuba-Brophy system in the past, although the agreement with CDFG permits 600 cfs to be diverted.
- Brown's Valley canal diverts water from the north bank of the river, about 4,200 feet upstream of the dam, at estimated flows of up to 100 cfs. Water enters an excavated side channel, from where it is pumped. This diversion currently has no functional fish screen. An attempt to screen the diversion with a small rock gabion weir was ineffective, and diversions now bypass the gabion and flow directly to the pump intakes.

A last hydraulic structure of note is a dewatering channel dug to lower the water level in the Yuba Goldfields area south and west of the dam. This ditch collects subsurface and surface flows, and empties them into the Yuba River at a point about 7,500 feet downstream of the dam. Flows enter the Yuba via this channel year-round, ranging from about 45 to 150 cfs at lower river flows (i.e., less than 1,000 cfs at Marysville), to 100 to 400 cfs at high river levels (i.e., greater than 2,000 cfs at Marysville) (Smith 1990). The lower flows in each flow-range occur when water is being diverted by the South Yuba-Brophy system; this is because of hydraulic connections between the water diversion system and the dewatering channel (Smith 1990; SWRCB 1991). In December 1988 this channel attracted at least several hundred fall-run chinook (Smith 1990), and observers have noted substantial numbers in several subsequent years. The velocity, flow volume, and location of the channel's outfall combine to create an attraction to salmon. A screen installed to prevent adult salmon from entering the outfall has failed more than once, as evidenced by adult salmon observed in the Goldfields in 1992 and 1993.

METHODS

The Service has sought input from governmental agencies and non-governmental organizations with experience and knowledge about natural resource conditions in the lower Yuba River drainage, and with expertise in dams, fish ladders and water diversions, and how they affect fisheries. Principal groups consulted were: CDFG, NMFS, and the Service; a comprehensive list of organizations and individuals contacted is in Appendix C. This report represents the biological judgment of the Service, and is based upon our professional experience, and guided by the information provided by the experts consulted.

Previous studies were an important source of information as well; principal documents used in report preparation are listed under "References". Because of time constraints, the list of references is not exhaustive, but we believe it contains the principal published reports on lower Yuba River fisheries.

Service personnel visited the study area twice in March 1994. On 22 March, G. Falxa and S. Schoenberg surveyed the river by canoe, from the Highway 20 bridge to the Hallwood Boulevard access, a total of about 11 miles; all relevant structures and diversions were inspected on this trip. On 28 March, G. Falxa visited Daguerre Point Dam with 2 fisheries biologists from the Service's Fishery Resource Office in Red Bluff (J. Big Eagle and M. Brown), who provided input on needed studies in the lower Yuba.

CONCERNS IDENTIFIED DURING STUDY

The following discussion is based on the best available information, which in many cases is casual observation and general impressions. Rigorous field studies must be conducted in order to understand and evaluate the processes discussed below before proceeding with any major changes to diversions or fishways.

General Concerns

Several principal fisheries problems exist around Daguerre Point Dam:

- dam-caused delays of upstream migration of adult salmon and steelhead, including problems adult fish may have in locating and ascending ladders;
- concentrations of predators, resulting in high losses of juvenile salmonids; Sacramento squawfish (*Ptychocheilus grandis*) are the main predators, but other fish species may be important. Points of predator concentration are pools above and below the dam, and diversion canals;
- losses of juvenile salmonids into water diversions (entrainment), particularly into the unscreened Brown's Valley diversion, and into the Hallwood-Cordua diversion when the screen is not operating. None of the diversions near Daguerre Point dam have screens which meet standards currently recommended by the state of California (CDFG 1991; Appendix F);
- poaching of adult salmon at fish ladders and in vicinity of dam;
- the dam preventing American shad from passing upstream in most years.

Three additional concerns pertain to the entire lower Yuba River:

• sub-optimal quality of spawning gravel habitat for salmonids, particularly below Daguerre Point Dam, and between Englebright Dam and the Highway 20 bridge. Available rearing habitat may also be suboptimal;
• impacts of inadequate and varying stream flows, resulting in high water temperatures, stranding of fish, and exposure of salmonid nests to desiccation and deleterious temperatures; and
• lack of data on the status of spring-run chinook in the Yuba, which impedes management efforts.

<u>Adult Passage Problems at Daguerre Point Dam</u>

Adult salmonids and shad encounter Daguerre Point Dam during their upstream migration to spawning areas. Factors which may impede or prevent their passage above the dam include suboptimal ladder design and operation, sheet flow across the dam spillway confusing fish and obscuring ladder entrances, and poaching at the fish ladders.

While many salmon migrate past Daguerre Point Dam successfully, delays at dams can be long enough (e.g., up to 50 days at Red Bluff Dam: USFWS 1988) to significantly affect fish health and spawning. Fish delayed at the dam may choose to spawn below the dam rather than above it, and fisheries biologists have observed that spawning gravel quality appears better above the dam than below. Use of suboptimal spawning habitat can impact fish populations by reducing reproductive success. Passage problems at Daguerre Point Dam could also prevent spring-run chinook from reaching the cool water and over-summer holding pools above the dam; fish trapped below the dam encounter sub-optimal to lethally-warm water temperatures and inadequate flows during the summer.

Poaching of adult salmon at ladders and at the base of the dam is well documented by CDFG, and is a chronic problem. In the past, poachers have tampered with fish ladders to block passage and to enhance poaching success. Any factor which delays adult passage into and through the ladders will increase salmon density just below the dam, which creates an attraction for poachers, and increases fish vulnerability.

Passage problems exist at the fish ladders. Of major concern is the lack of regular monitoring and adjustment of ladders to maintain optimal flow through ladders, and to spot and correct problems. For example, during a facility inspection on October 30, 1992, FWS and NMFS personnel observed that water velocities appeared excessive at the 180-degree bend of the north-bank ladder. They also observed a freshly-dead chinook female salmon outside this bend of the ladder--likely a victim of poor passage conditions in the ladder.

Fish ladders are designed to operate effectively within a limited range of flows. If flows are not within this range, hydraulic conditions in the ladder may prevent fish from locating moving quickly and safely through the ladder. Corps personnel inspect Daguerre Point Dam about twice monthly to maintain the dam and ladders. Flow criteria for optimal operation of the dam's ladders appear to be unavailable, and the ladders lack gauges to measure flow through them. Since neither guidelines nor gauges exist, current Corps policy is to leave the gates controlling flow into fish ladders wide open at all times. As a result, fish passage conditions in the ladders may often be suboptimal.

Evidence for the existence of passage problems is found in the relationship between winter flows and the distribution of adult fall-run chinook above and below the dam (Figure 2). A smaller proportion of salmon spawned above the dam during winters with higher flows, based on fall carcass surveys conducted by CDFG. This suggests that passage at the dam is hindered as total river flow increases. Spawning distribution could also be affected by water temperatures below Daguerre Point Dam, which tend to be cooler (and more conducive to spawning) when the river flows are higher.

Two factors which may contribute to passage problems are spillway design and the location of downstream entrances to ladders. The dam produces sheet flow across the length of its spillway. This flow attracts adult salmonids, which have been observed attempting to ascend the dam (unsuccessfully). The spillway configuration may also obscure fishway entrances, particularly during high flows. Also, ladder entrances may not be optimally placed to attract fish during higher-flow periods (normally November-April), which coincide with the upstream migration of fall-run chinook and steelhead trout (September through January for salmon; August through March for steelhead; Figures 3, 4).

The existing fish ladders are relatively small, compared to ladders that are currently being designed for some rivers. Ladder function and attraction to fish movement of adult salmon through ladders may be suboptimal as a result of poor hydraulics which exist under some flow conditions.

A last concern is that few American shad move up existing fish ladders; shad require ladders with a lower gradient and flow speed than do salmonids. Shad are not native to the Sacramento system, but have been well established since the late-1800's, and are the focus of a popular sport fishery.

<u>Increased Predation Losses of Juvenile Salmonids</u>

Dams and diversions are known to expose juvenile salmon to predation rates unlikely to occur under natural conditions (e.g., USFWS 1988). Causes for higher predation risk at these sites include: (1) disorientation of juvenile by hydraulics at diversions, bypasses and dam spillways; (2) concentration of juveniles by fishways and fish screen bypasses; and (3) creation of pools above and below dams, and at diversions, which provide good habitat for squawfish and other predators, and which are often located where concentrations of disoriented migrant juvenile fish occur.

Suspected problem areas for predation include:

- pools directly above and below Daguerre Point Dam attract squawfish;
- juveniles entering the Hallwood-Cordua diversion are reported to experience predator concentrations in the 1,500 feet of channel between the dam and the fish screen (Hall 1979; Kano 1987);
- fish entering the South Yuba-Brophy works encounter predatory fish in the 1.6 acre pool in front of the rock weir (Konnoff 1988). Exposure to predation here may be exacerbated because up to 90% or more of the flow entering the diversion passes through the gabion, with the rest returning to the river. Low velocities and flows sweeping *past* the gabion combined with high flows *through* the gabion may delay migrating juveniles in the pool, before they find the small bypass flow returning to the river.

Figure 2. Spawning distribution of fall-run chinook salmon in the Yuba River relative to Daguerre Point Dam, under different river levels. Data is from period since New Bullards Bar Dam; river conditions were markedly different before that dam's construction. Comparable data was not available for all years. Spawning distribution is based on CDFG surveys of salmon carcasses. October flows were chosen because upstream salmon migration peaks in that month.

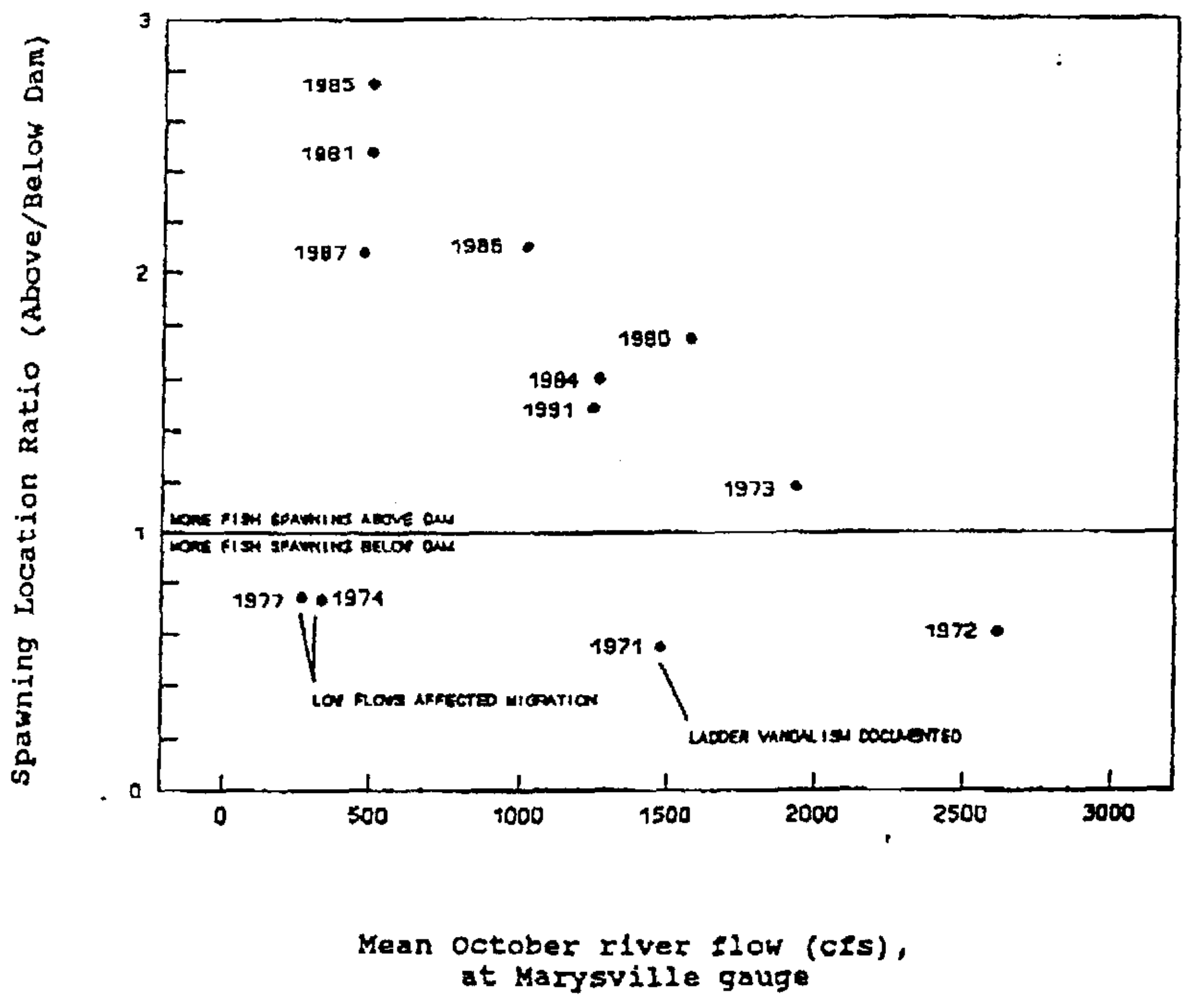

Figure 3. Mean monthly flows at selected U.S. Geological Survey gauge stations on the lower Yuba River, California: Smartville (estimated unimpaired flows for water years 1921-1983); below Englebright Dam (impaired flows for water years 1969-1988), and near Marysville (impaired flows for water years 1969-1988). "Unimpaired" refers to flows in absence of dams or other structures affecting flow. Source: CDFG 1991.

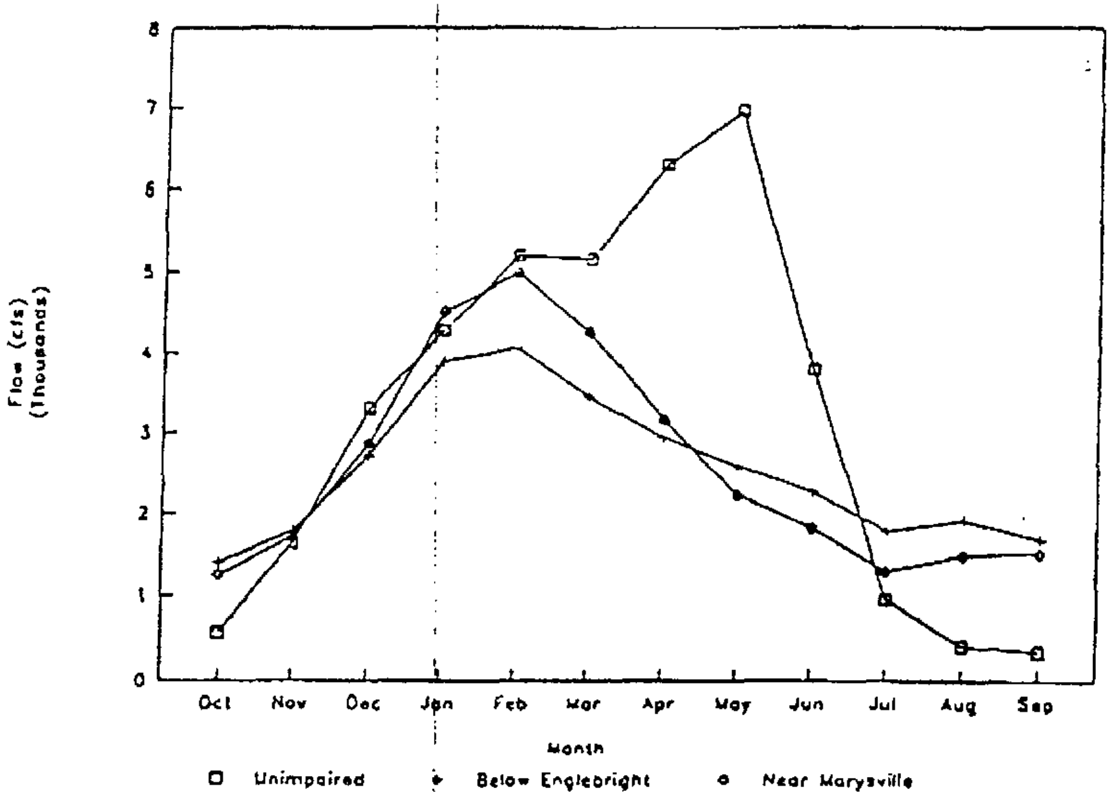

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Figure 4. Life history periodicity for fall- and spring-run chinook salmon, steelhead trout, and American shad in the lower Yuba River, California.*

Fall-run Chinook Salmon Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning migration	X								X	X	X	X
Spawning	X									X	X	X
Egg incubation	X	X								X	X	X
Emergence	X	X	X									X
Fry rearing/emigration	X	X	X									X
Juv rearing/emigration				X	X	X						

Spring-run Chinook Salmon Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning migration			X	X	X	X	X					
Summer holding						X	X	X				
Spawning									X	X	X	
Egg incubation									X	X	X	X
Emergence	X										X	X
Fry rearing/emigration	X	X	X									X
Juv rearing/emigration			X	X	X	X						

Steelhead Trout Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning migration	X	X	X					X	X	X	X	X
Spawning	X	X	X	X								
Egg incubation	X	X	X	X	X							
Emergence		X	X	X	X	X						
Fry & Juv rearing	X	X	X	X	X	X	X	X	X	X	X	X
Emigration			X	X	X	X						

American Shad Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning migration				X	X	X						
Spawning					X	X	X					
Egg incubation & hatching					X	X	X					
Rearing & emigration					X	X	X	X	X	X	X	

* Source: CDFG 1991. The periods shown are believed to represent the time of occurrence of an unknown but large majority of a life stage population; consequently, exceptions may commonly occur. In chinook salmon, young fish may emigrate as young fry, or as older juveniles.

Losses of Juveniles into Diversion Flows

Some juvenile fish leave the river and enter diversion canals or pipes; among fisheries biologists often refer to such fish as "entrained". Fish screens are designed to prevent entrainment, as entrained salmonids are effectively dead. Losses into diversions are potentially substantial, particularly because diversion season coincides with the downstream migration of young chinook salmon and steelhead (Figure 4). The CDFG (1991) concluded that losses of juvenile salmonids occur at the Brown's Valley, South Yuba-Brophy, and Hallwood-Cordua water diversions. In that report CDFG also recommended installing new "state of the art" fish screens, directly on the river, at all three diversions.

Entrainment problem areas include:

- Brown's Valley diversion, although small, is unscreened and causes unknown fish losses.
- Hallwood-Cordua fish screen is operated only during the estimated peak period for downstream migration of juvenile fall-run chinook, which typically is about April through June. Periods occur when water is diverted but the screen is not operated; some salmon and steelhead juveniles migrate during these times, and those which enter the diversion are lost.
- South Yuba-Brophy gabion weir: its effectiveness in excluding juvenile salmonids has been disputed (Konnoff 1988; Smith 1990; CDFG 1991; SWRCB 1991; Cramer 1992). Recently-emerged fry may be able to pass through the screen, but most fall-run salmon fry emerge outside the diversion season; however, steelhead and spring-run chinook emerge as late as June.
- Yuba Goldfields dewatering channel: juvenile salmonids are sometimes trapped or stranded in the maze of interconnected channels and pools (Smith 1990). These juveniles probably hatched from adults which spawned in the Goldfields, but may have entered the Goldfields via the outfall. Adult fall-run salmon have entered the Goldfields in many recent years (e.g., 1992, 1993), in spite of attempts to screen the outfall. The Service is concerned that spawning and rearing conditions in the Goldfields are poor, and inadequate for the large number of adult salmon which sometimes enter the area. Furthermore, during high flows adults, juveniles and fry may be entrained into the South Yuba-Brophy canal from the Goldfields channel.

Physical Damage and Disorientation

"Impingement" is damage or death caused by striking or being pinned against a structure, such as a perforated metal fish screen, and can occur under certain hydraulic conditions. Opportunity for impingement exists on the Hallwood-Cordua fish screen, but the consensus of opinion is that this is probably not a problem. Disorientation of migrating juvenile fish may occur at the Daguerre Point Dam spillway. While spillways can be benign to downstream-migrating juvenile salmon (Wilson et al. 1991), the fate of fish passing over the Daguerre Point Dam spillway is of concern because the spillway design can cause stable recirculating currents or "hydraulics" at the spillway base. Such hydraulics are likely to disorient fish, which would increase their vulnerability to other hazards, such as predatory fish.

Cumulative Juvenile Losses
While losses due to any single cause at any one diversion may appear small, the cumulative effects can be substantial. Losses of migrating juveniles could be substantial at any of several sites. Studies on the Yuba River suggested losses at the South Yuba-Brophy diversion of 40-60% (Konnoff 1988), and observed losses at Red Bluff Dam and diversion ranged from 18 to 77 per cent (USFWS 1988; Hallock 1983, cited in USFWS 1988). Losses observed in these studies include losses to predation, impingement, and entrainment; it is difficult to identify sources of losses without studies more detailed than those made to date on the Yuba.

The issue of juvenile losses is a serious one. An average of about 28 to 33 percent of the river's flow is diverted at Daguerre Point Dam and nearby Brown's Valley intake during May and June, the peak period when juvenile salmon and steelhead are migrating downstream. The above figures are based on *average* flow conditions, and should be viewed cautiously. During years with below-average rainfall, diversions would take up to 75 percent of river flow during these same months, if the existing minimum flow schedule is followed. Diversions are permitted to take an even greater portion of the flow during years when stream flow is 50 percent or less of normal; under these conditions over 90 percent of flow could be diverted in May and June, based on historic diversions and minimum required flows.

The magnitude of these diversions is cause for concern. Studies elsewhere in California have found the number of migrating juveniles entering a diversion canal to be proportional to the amount of flow diverted (USFWS 1988). For example, if 25% of the river's flow enters a diversion, one assumes 25% of the migrating fish also enter the diversion. Of these, as few as half may return to the river alive and well, at survival rates of 50%; this equals a net loss, at that single diversion, of over 10% of the entire migrating population. Even if losses are lower at a diversion, they can be substantial because so much of the total river flow enters diversions at and near Daguerre Point Dam.

Flow Gauging Problems
The inability to measure flows at Daguerre Point Dam has multiple impacts on fisheries. As discussed above ("Adult Passage Problems"), ladder gauges are needed to maintain flows which maximize fish passage through the ladders. Also, the operating license for New Bullards Bar Dam states that minimum flow requirements for the lower Yuba River shall be measured "over crest of Daguerre Point Dam and through fishway" (FPC 1966). No gauges exist to measure minimum flows at the dam--minimum flows are instead based on measurements at the Marysville gauge, located 6.2 miles above the confluence with the Feather River. Measurements here do not represent flows at the mouth, because about 10 diversions exist below the Marysville gauge for riparian water rights. The licensing agreement for New Bullards Bar Dam states that minimum flows at Daguerre Point Dam "shall be in addition to releases to satisfy existing downstream water rights" (FPC 1966). While minimum-flow releases into the lower Yuba include a small amount added for estimated losses below the Marysville gauge, the actual amount of those losses is unknown.

Special Status Species
The following discussion of federally-listed threatened and endangered species should be regarded as preliminary information, which the Service is providing to assist the Corps in consultations and/or preparation of any Biological Assessment for the project, should one be deemed necessary. The Corps' responsibilities for such assessments, and for compliance with sections 7(a) and (c) of the Endangered Species Act of 1973, as amended (Act), are briefly outlined in the attached Appendix A. In addition, the Service recommends the Corps review all of its responsibilities under the Act and the procedural regulations governing interagency cooperation under section 7 (50 CFR 402).

Federally-listed Threatened and Endangered Species
Species which may occur in the Yuba River Basin Investigation project area are listed in the Service's 27 November 1992 letter to the Corps, which is contained in the Service's Planning Aid Report on the current investigation (USFWS 1993). That list included federally-listed endangered and threatened, proposed, and candidate species (USFWS 1993), and includes:

winter-run chinook salmon (*Oncorhynchus tshawytscha*)--Endangered
bald eagle (*Haliaeetus leucocephalus*)--Endangered
American peregrine falcon (*Falco peregrinus anatum*)--Endangered
valley elderberry longhorn beetle (*Desmocerus californicus dimorphis*)--
Threatened
giant garter snake (*Thamnophis gigas*)--Threatened

A discussion of federally-listed species which may occur in the project area can be found in the Service's Planning Aid Report on the project (USFWS 1993). However, the status of several species has changed since the Service's November 1992 letter. For example, winter-run chinook salmon are now listed as endangered; this fish is not known to spawn in the study area, but may use the area minimally (USFWS 1993). Also, the Sacramento splittail (*Pogonichthys macrolepidotus*) is a fish which may occur in the river, and which is currently proposed for Federal listing. Restoration efforts that involve changes in flow will need to be evaluated with regard to Sacramento splittail and the Federally-listed threatened delta smelt (*Hypomesus transpacificus*). Delta smelt critical habitat has been proposed (Federal Register 59, 852), and Yuba River flows may affect their habitat.

Several species which are candidates for Federal listing may occur in the project area. Three plant candidate species occur in upland habitat in the Yuba River watershed: Butte fritillary (*Fritillaria eastwoodiae*), Cedar Crest allocarya (*Plagiobothrys glyptocarpus* var. *modestus*), and Scadden Flat checkermallow (*Sidalcea stipularis*). If any restoration takes place away from riparian areas, surveys for these plants species would be needed. Other candidate species are the northwestern pond turtle (*Clemmys marmorata marmorata*), which may occur in quiet stretches, irrigation ditches or backwaters, and the western spadefoot toad (*Scaphiopus hammondi hammondi*), which may breed in very quiet backwaters, and use adjacent upland habitat.

The following discussion of bald eagles is included here because the Yuba River near Daguerre Point Dam may be important winter habitat for bald eagles.

Bald eagles are among the federally-listed species which may occur in the study area. Bald eagles migrate through and winter sparsely in the Sacramento Valley, and observers have noted as many as 10 bald eagles along the river during the winter, in the vicinity of Daguerre Point Dam and in the Yuba Goldfields (R. DeHaven and D. Weinrich, pers. comm.). Salmon runs represent important food sources for bald eagles; presumably the eagles are attracted to the Yuba River by fall-run chinook salmon. Bald eagles feed mainly on fish, and by scavenging on waterfowl and mammals. They generally require lakes, reservoirs, or free-flowing rivers with abundant fish, and adjacent snags or other perches. While restoration measures which increase fish populations will likely benefit eagles, the impact of restoration measures on bald eagles and other listed species should be assessed during preparation of a Fish and Wildlife Coordination Act report.

State-listed Species

State-listed species, including the State-threatened bank swallow (*Riparia riparia*) may occur in the study area; burrows which may have been used by this species were observed in a bank near Daguerre Point Dam during a field visit in March 1994. The CDFG should be consulted regarding this and other State-listed species which may be impacted by restoration activities.

POTENTIAL RESTORATION MEASURES AT DAGUERRE POINT DAM AND VICINITY

The Service recommends that two types of restoration measures be taken:

- Immediate measures can be implemented within months, at relatively small expense (e.g., in the range of tens of thousands of dollars for most measures), and are expected to benefit fish populations.
- Long-term measures would be relatively expensive and require substantial planning and design. These are expected to have substantial benefits to fish populations and other biological resources.

Table 1 contains a summary of benefits and costs of some restoration measures. The Service's recommended option is removal of Daguerre Point Dam.

Preferred Long-Term Restoration Measure: Remove Daguerre Point Dam

The Service recommends that removal of Daguerre Point Dam be considered foremost among major restorative measures, because dam removal provides the greatest opportunity for significant, lasting benefits to fisheries and the lower Yuba River system as a whole.

Strong biological and financial arguments exist for dam removal. The fisheries problems associated with the dam are described elsewhere in this report. Almost unanimously, biologists and fisheries engineers consulted during this study stated that dam removal would be the best restorative action for Yuba River fish populations. Also, Federal interest and involvement in dam removal is rapidly increasing, as indicated by recent support by the Secretary of the Interior for allocating up to 315 million dollars in 1995 for studies of dam removals (Los Angeles Times 1994).

Table 1. Summary of estimated benefits and costs of restoration measures proposed for the lower Yuba River, CA

RESTORATION MEASURE	ESTIMATED BENEFITS								COST RANGE ESTIMATE (Dollars)
	Restore Ecosystem Function	Increase Juv. Salmon Survival: By Reducing Predation	Increase Juv. Salmon Survival: By Reducing Entrainment	Improve adult salmon passage	Improve shad passage	Improve salmon spawning and rearing habitat	Reduce poaching at dam	Increased public safety	
Immediate Actions:									
Improve fish ladder operation		Small-to-moderate		Small-to-moderate	Small		Small-to-moderate		<10,000
Improve Hallwood-Cordua diversion screen		Small-to-moderate	Moderate						few 100 thousands
Screen Brown's Valley diversion		Small	Moderate-to large						200,000-300,000
Conduct fisheries and gravel studies	Benefits to fish populations would be determined by study results, and by follow-through of studies with appropriate restorative actions								400,000-700,000
Study feasibility of dam removal	Benefits to river ecosystem would be determined by study results; estimated benefits of dam removal are listed below								several 100,000
Long-term Actions:									
Remove Daguerre Pt. Dam	Large benefit	Moderate-to large	Small	Moderate-to large	Large	Moderate	Moderate	Moderate-to large	1-5 million
Screen Diversions to existing standards			Moderate-to large						2-3 million
Replace or upgrade fish ladders		Small-to-moderate		Moderate-to large	Small-to-large		Moderate		To replace: 2-3 million
Modify dam spillway		Small-to-moderate		Small-to-moderate			Small-to-moderate		not estimated
Habitat Enhancement:									
Replenish spawning gravels						Moderate-to-large			not estimated
Resolve Goldfields issues	Small-to-moderate.		Small-to-moderate			Small-to-moderate			not estimated
Side-channel habitat enhancement		Small-to-moderate				Small-to-moderate			not estimated

Notes: 1. "salmon" includes Chinook Salmon and Steelhead Trout

2. Fish screen replacement costs are based on constructing state-of-the-art screens

3. All cost estimates are to be considered rough and preliminary

Long-term restoration measures for the lower Yuba River are costly, and their relative biological benefits are not known at this time. While the benefits of dam removal are not fully known, removal would represent a major step in <u>restoring</u> the river and its fisheries to a pre-dam state. Furthermore, removal offers long-lasting restoration benefits which could be amortized over a very long time period, while other restoration actions typically require continued expenditures to maintain benefits, *in addition to* the continued costs of dam maintenance and operation.

The Service considers Daguerre Point Dam an obsolete structure which no longer serves its intended purpose of capturing sediment--it is full of sediment and has been for decades. There appears to be no identifiable benefit of the dam to the Corps, while removal would offer an opportunity to improve the fisheries while avoiding maintenance and operation costs--expenses which may increase as the dam gets older, and if the Corps implements other measures to restore and improve fisheries, as described in this document.

Benefits of dam removal would also be accrued by California Department of Fish and Game, which for years has provided personnel to operate the fish screens at Hallwood-Cordua during water diversion season, and wardens to monitor the fish ladders at the dam for poachers. These ongoing costs would be greatly reduced by dam removal.

Daguerre Point Dam currently serves as a diversion point for several water districts, which have taken advantage of the dam's presence to divert water. The dam, however, was not designed as a diversion dam, and to the Service's knowledge, the Corps has no obligation to serve these water users. In fact, it is believed that the operators of the diversion on the south bank have argued in court that their diversion was "off river", and hence required no Corps permit. Clearly, dam removal should be coordinated with water-rights holders, and efforts made to assist them in securing alternative means to divert water. Fish-friendly technology exists for diverting water without a dam, e.g., with screw pumps, or subsurface pumping with Rainey collectors.

Should the dam be removed, sediments trapped behind it could move downstream. This might, at least temporarily, alter stream channels dynamics or water quality. However, the Service is not aware of any data on the sediments trapped behind the dam. An early step in analysis of dam removal should be to conduct core sampling and any other studies needed to estimate the amount and composition of the sediments to be affected by dam removal. The result of these studies should help guide decisions regarding the sediment handling. Approaches to sediment handling might include: (1) removing sediments and using them to enhance habitat, e.g., to replenish spawning gravel in areas where gravel loss has occurred; (2) dredging a channel for the river to pass through the accumulated sediment, and allowing remaining sediments to equilibrate during high flows; and (3) using sediments unsuitable for habitat enhancement as construction material, e.g., as fill.

Proposals to remove obsolete dams are receiving positive attention because of fisheries and other benefits. Support comes from a diversity of governmental agencies, including CDFG, the National Park Service, the Corps, and the Bureau of Reclamation, in addition to widespread popular support. A number of dams have been successfully removed by humans and by nature (Appendix E).

Other Long-Term Restoration Measures

Several additional restoration measures have been identified, in addition to dam removal; the first two measures would be needed only if Daguerre Point Dam remains. These measures can be undertaken alone or in combination:

Replace or upgrade fish ladders

The fish ladders may require changes beyond those described above under Immediate Restoration Measures. The Corps should investigate what changes are necessary at Daguerre Point Dam to ensure that fish passage is "state-of-the-art" relative to current standards for anadromous salmonids in the Pacific Northwest, where the majority of work on passage designs has been done.

The investigation should use both biologists and engineers to identify passage problems and solutions. The investigation should consider options ranging from altering current ladders, to adding an additional ladder mid-dam, to completely replacing existing ladders with new ladders. The goal should be to permit fish to move upstream past Daguerre Point Dam with minimal delay and injury. Ladders should provide efficient passage over the range of flows that commonly occur in the river, especially when adult salmonids are migrating. A suggested range of flows might be from 70 cfs (current minimum) to about 5,000 cfs, based on mean monthly flows from historic records. Furthermore, ladder designs should be considered which permit American shad passage.

Modify dam spillway

Flow over the existing spillway may obscure fish ladder entrances, as well as creating hydraulic conditions which could disorient or otherwise harm fish, particularly juveniles. The Corps should investigate spillway modifications to lessen these problems. One modification would be to notch the spillway near each end of the dam, which could have the benefits of increasing attraction of upstream migrating fish to the vicinity of the fish ladder entrances, as well as reducing recirculating hydraulics below the spillway.

Should new fishways be constructed, the spillway may require concurrent modifications to permit greater control over the flows entering the fishways. Preferably, new fishways would be designed to accommodate most or all the river's flow at lower flow volumes.

Replace fish screens with state of art screens. Desirable features of screens include:

- placement at the point of diversion in the river, to minimize exposure of juvenile fish to predators;
- screens which meet Federal and State criteria for approach and sweeping velocities, screen dimensions, and screen porosity;
- structures placed in-stream to create flows which direct fish away from the diversion entrance; and
- optimal design of fish bypasses.

Examples of state-of-the-art screens are provided in Appendix F.

Explore habitat enhancement opportunities elsewhere in the lower Yuba
CDFG (1991) discusses habitat improvement in the lower Yuba. Measures to consider include:

- transport spawning-quality gravel to the reach between Englebright Dam and the Highway 20 bridge, to replace the upstream sources of gravel recruitment which that dam cut off. The quantity and quality of spawning gravel has declined in this reach, and perhaps elsewhere, since construction of Englebright Dam (CDFG 1991; Wooster and Wickwire 1970). It may be best to place gravel just below the Narrows, so as to not alter the large pools in the Narrows, where spring-run chinook are believed to spend the summer.
- minimize gravel extraction operations within the lower Yuba River floodplain; gravel extraction can remove important spawning substrate, as well as altering river channel hydrology.
- manipulate habitat of instream side-channels to improve juvenile rearing conditions.
- explore habitat enhancement in the Yuba Goldfields, although biologists strongly disagree on whether the Goldfields provide good salmon habitat, or are a biological sink. Also, ongoing ownership disputes in the Goldfields could complicate actions there.
- remove or set back the tall sediment piles and training levees which parallel much of the river channel. These banks typically rise at angles of 40 to 50 degrees, constraining the river channel. Moving these walls could benefit salmonid fry and juveniles by increasing the amount of broad flat gravel bars used as rearing habitat.

<u>Immediate Restoration Measures</u>

Develop and implement guidelines for fish ladder operation
Guidelines should be established and implemented for the operation and maintenance of the Daguerre Point Dam fish ladders. It is the Service's understanding that the Corps is responsible for actual maintenance and operation of Daguerre Point Dam ladders; thus, the Corps should take primary responsibility for the guidelines, in consultation with the CDFG, NMFS, and the Service. We recommend that the Corps should take any actions needed to operate and maintain ladders in conditions optimal for fish passage.

Appendix D provides an example of the elements the Service would like to see included in such guidelines.

Install gauges to permit flow measurements at Daguerre Point Dam
Appropriate operation of the fish ladders would require the installation of gauges to measure flow through each ladder. The Service recommends that the Corps affix staff gauges to: (1) the upstream vertical face of the dam; (2) inside each fish ladder near the upstream end (i.e., on either side of the gated or exit orifice); (3) the upstream and downstream surfaces of the entrance (i.e., downstream) orifice for each ladder. The first two gauges would allow calculation of the water volume entering each ladder, when combined with data on the size of exit orifices. Gauges at each entrance orifice would allow monitoring the attraction discharge at each ladder. Finally, gauges should be placed for easy viewing by maintenance personnel, and surveyed and calibrated to a common datum.

Improvements to Fish Screen at Hallwood-Cordua Diversion
Because of high operating costs, the screen cannot be operated at all times when juvenile salmonids are migrating. The major factor limiting effective operation of this screen is the need for continuous attendance. The screens need attendance for 2 reasons: the screens need to be manually cleaned, and the fish must be manually collected and transported in a truck back to the river. Short-term improvements, which can be accomplished quickly and fairly cheaply, would be:

1. Bring electricity lines to the screen, and install electric-powered, automated screen cleaners.
2. Install a bypass pipe to return fish directly to the river from the screen, thus avoiding potentially harmful fish handling. The bypass should be designed to have hydraulics which are fish-friendly, and to return fish to the river in a way that minimizes predator exposure at the pipe outlet (for suggestions and sources for bypass designs see HDR Engineering 1993).
3. Regularly monitor and maintain the screen. This might be done most efficiently in conjunction with fish ladder maintenance visits, during the times when adult salmonid and juvenile migration coincide.

The greatest benefit of these modifications is that the screen facility could be operated without constant attendance. As a result, it could be operated throughout the diversion season, which would avoid the losses which now occur when the screen is not operated.

Install screens at Brown's Valley and other unscreened diversions
The Brown's Valley diversion is unacceptable from a fisheries viewpoint--the diversion should have a modern, effective fish-excluding device. Creative alternatives could also be explored, such as the district taking its water from the Hallwood-Cordua diversion, which is screened. The latter canal is, in places, within 700 feet of the Brown's Valley canal.

All Yuba River diversions between Daguerre Point Dam and the river mouth should be inventoried, and evaluated for entrainment problems. The inventory should identify ownership, location, and volume and timing of diversions, as well as options and opportunities for reducing entrainment.

Take measures to reduce attraction of fish to existing diversions
The inlets to some or all diversions may be amenable to simple modifications which would tend to move juvenile salmonids past the inlets, keeping them in the main river stream. Screen experts should be consulted for this work.

Coordinate restoration and enhancement activities
The Corps should consult and coordinate with other parties active in restoration in the Yuba watershed. This includes CDFG, local water agencies, PG&E, Corps, NMFS, Service, and private sports fishing groups.

<u>Restoration Schedule</u>
The restoration effort could be accomplished by the Corps using the following stepwise process:

1. Institute the <u>Immediate Restoration Measures</u>, described above, and analyze the benefits of <u>Long-Term</u> restoration measures to determine appropriate next steps, focusing on dam removal as the preferred option.

2. Design a plan for dam removal;

or, should dam removal not be pursued as a first course of action:
Conduct biological studies to identify long-term restoration options offering the greatest benefit to fisheries and other resources.

3. Remove Daguerre Point Dam;

or, if dam removal was found not feasible:
Choose and implement other long-term restoration measures.

The immediate measures can be accomplished quickly, at relatively low cost, and have a high likelihood of providing substantial biological benefits. These measures can (and should) be enacted as soon as possible.

While the immediate measures are being undertaken, more substantial restoration measures should be investigated. The Service believes that the feasibility of dam removal should be emphasized in studies of long-term restoration measures. The Service also believes the analyses should reflect the fact that dam removal offers restoration benefits in perpetuity, while other restoration options would generally require regular attention, in the form of maintenance and operation, to maintain their restoration benefits.

The removal of Daguerre Point Dam would best rectify the plethora of problems identified by experts. However, should the Corps focus on long-term restoration measures other than dam removal, case studies should precede choosing specific restoration measures. This recommendation is based on 3 facts: (1) long-term restoration options required substantial and costly construction to improve fish passage and reduce fish losses; (2) there is minimal data on the specific effects of Daguerre Point Dam on fish passage (upstream or downstream), and limited data on fish losses at diversions; and (3) funds are always limited, so wise choices will have to be made. Thus, the appropriate first step is to conduct biological and engineering studies designed to quantify specific impacts of the dam on fish populations, and to identify appropriate measures to reduce those impacts. The results from these studies would guide long-term restoration measures, which could include any of the measures contained in this report, including dam removal.

Fisheries and Related Studies

As described above, an appropriate restoration measure is to design and carry out studies of the effects of Daguerre Point Dam on anadromous fisheries. Research topics are listed below which would identify Yuba River fisheries problems associated with Daguerre Point Dam and vicinity.

Factors affecting upstream passage of adults at the dam. Studies would focus on the effectiveness of fish ladders in attracting and passing fish under different flow conditions, and address questions including:

- how do fish behave when approaching the dam and fish ladders?
- does the dam delay or prevent adult passage?
- what are hydraulic conditions below the dam and in the fish ladders, and what can be done to improve passage?

Factors affecting downstream passage of juvenile salmonids. Topics to address include:

- what proportion pass through ladders, over spillway, into diversions, relative to flows?
- what are losses to predation by squawfish and other fishes, and do disorientation or other factors contribute to predation losses?

Entrainment losses of juvenile salmonid at water diversions.

- what are losses at Brown's Valley diversion, and at smaller unscreened diversions downstream?
- what are entrainment losses at the Hallwood-Cordua diversion and, particularly, the South Yuba-Brophy diversion and all of its associated channels and structures (e.g., channels leading to and from weir)?

Fate of salmon entering the Goldfields dewatering channel outflow.

- what is fate of adults entering the outflow channel? Is there adequate spawning habitat for them?
- what is fate of juveniles spawned in the Goldfields system?
- does the outfall flow attract juveniles; if so, what is their fate?

Hydrology, geomorphology studies.

- how would dam removal affect hydrology, geomorphology, and distribution of sediments, including spawning substrate?
- what is the quantity and quality of sediments trapped behind the dam?
- what options exist for removing or otherwise managing the sediments accumulated behind the dam?
- what is the current and future status of salmonid spawning and rearing habitat on the lower Yuba River?

PRELIMINARY COST ESTIMATES FOR RESTORATION MEASURES

These estimates are provided as very rough approximations of the costs which might be involved for different restoration measures. Serious consideration of any of the following restoration measures should be preceded by the fisheries studies outlined above, and should employ technical experts to design detailed restoration plans and estimate costs for those plans.

<u>Dam Removal</u>

Estimates for recently proposed dam removals have ranged from under 5 million dollars to more than $100 million, for dams much larger than Daguerre Point Dam (e.g., the Bureau of Reclamation estimates $5 million to remove Savage Rapids Dam, an irrigation dam on the Rogue River measuring 39 feet high and 380 feet long; rough estimates range from one to several million dollars for removing Rindge Dam on Malibu Creek in southern California, a concrete dam 100 feet high, and 95 to 175 feet wide; see Appendix E for more examples).

Costs of dam removal could be defrayed by creative planning. Cost-sharing options may exist. Also, sediment trapped behind the dam may be a valuable resource instead of a disposal problem. The Service prefers the use of suitable-quality sediments to replenish depleted spawning and rearing gravels in the lower Yuba watershed. For sediments unsuitable for habitat enhancement, the Corps might permit removal for construction or fill; sales or free removal of such sediment could reduce dam removal costs. This approach has been considered in the proposed Rindge Dam removal (Appendix E), where the costs of sediment removal may be reduced substantially by using the sediment for local projects, e.g., as fill, gravel, and beach sand renewal.

Sediment sampling and analysis at Rindge Dam cost about $70,000. Savage Rapids Dam studies have cost the Federal government about $600,000-$800,000, plus cost-sharing by the local sponsor, which was largely provided as labor (B. Hamilton, pers. comm.). These studies have included stages up to and including preparation of an Environmental Impact report.

Fisheries Studies

The following estimates are based primarily on information provided by the Service's Red Bluff fisheries office:

- evaluate adult salmon passage past dam: $100,000
  --research would use radiotelemetry
- evaluate predation on juvenile salmonids at and near dam: $150,000
  --includes studies of predator abundance, behavior, and food habits
- juvenile migration studies: $150,000.
  --employ screw traps and possible marking studies to monitor juvenile migration
- evaluate hydraulic conditions around dam: $50,000
  --areas requiring study include diversions and associated screen structures, in and around fish ladders, and the dam spillway
- distribution of salmon spawning: $100,000
  --use both aerial and underwater redd survey techniques to document spawning distribution above and below dam

New Fish Ladders

A very rough cost range is $10,000 to $100,000 per vertical foot of rise, with the upper end more likely for the best ladder design. At a rise of about 25 feet at Daguerre Point Dam, and $50,000 per foot, a rough cost estimate is 1.25 million dollars *per ladder*.

Examples of recent ladder constructions/proposals include:

Pool and Chute design was recently used in plans by CDFG for ladders on Butte Creek (designed to handle up to 300 cfs; vertical rise of about 8-9 feet; estimated price of $300,000 per ladder. Ladders at Daguerre Point Dam would need to handle greater flow volumes, and higher rises. At least four ladders of this design have been built, including one on Yakima River in Washington State. This design allows passage of high flow volumes.

Ice Harbor design is used widely on Columbia River. This design permits passage of shad as well as salmonids, and is the design which is probably the easiest for all fish to negotiate.

Fish Screen devices
- cost ranges somewhere between $1,000 to $10,000 per cfs for diversions in the range of 40-500 cfs (George Heise, CDFG; Jerry Big Eagle, USFWS)
- One Cost estimate for a new Hallwood-Cordua screen: $1 million, or about $2,000 per cfs, based on 500 cfs maximum diversion (estimate provided by the Service's Red Bluff office).
- One good example which might be useful is the screens at the Tehama-Colusa Canal, at Red Bluff Diversion Dam on the Sacramento River. It uses rotating drum screens, and was built by the Bureau of Reclamation to handle up to about 3,000 cfs. Cost was approximately 15 million dollars, or $5,000 per cfs. The screens at Red Bluff have proven very effective in preventing entrainment (J. Big Eagle, pers. comm.)
- See Appendix F for examples of recent fish screen designs

Dam Modification
No price estimate was made for dam modification. The Corps is much more knowledgeable about the specific features and costs of dam construction, and has better information on Daguerre Point Dam.

RECOMMENDATIONS

The Service recommends that the following measures form the nucleus for habitat restoration of the lower Yuba River:

1. Implement immediate measures to improve adult passage at Daguerre Point Dam. The following measures should be completed before September 1994, when fall-run chinook salmon enter the river:
   - develop and implement guidelines for operation of fish ladders at Daguerre Point Dam; and
   - install gauges to permit flow measurements at the fish ladders and spillway of Daguerre Point Dam; these are necessary for proper operation of fish ladders. Specific recommendations for gauge placement are found in this report.

2. Implement immediate measures to reduce losses of juvenile salmonids into diversions at and near Daguerre Point Dam. The following changes to diversions would best be made before March 1995, when juvenile salmonids begin to migrate downstream:
   - bring electricity lines to the fish screen at the Hallwood-Cordua diversion, and install electric-powered automated screen cleaners;
   - install a bypass pipe to return fish directly to the river from the screen bypass. The bypass design should be fish-friendly;
   - install effective fish screens at the Brown's Valley Irrigation diversion; and
   - consult with experts on ways to modify existing diversion inlets so as to reduce the attraction to juvenile salmonids, then modify the inlets.

3. Remove Daguerre Point Dam. This action offers the greatest and most secure long-term restoration benefits to the river ecosystem, including its fisheries. The Corps should take the lead in designing and implementing a plan for removing Daguerre Point Dam.

4. Determine the status of sediments in the lower Yuba River. This is important to dam removal, and to fish habitat. Studies should:
   • assess the current and projected status of salmonid spawning and rearing habitats in the lower Yuba River, both with and without dam removal;
   • determine the amount and composition of sediments which would be affected by the removal of Daguerre Point Dam; and
   • identify sediment management options should the dam be removed, including the use of sediments to enhance salmonid spawning and rearing habitat.

5. Enhance spawning and rearing habitat as determined appropriate, including placing appropriate gravel below Englebright Dam to compensate for blockage of gravel recruitment.

6. Request the Service to conduct fisheries studies to identify those long-term restoration options which offer the greatest benefit to fisheries and other resources. Should the Corps decide against removing Daguerre Point Dam at this time, these and engineering studies would the guide the selection and design of appropriate long-term restoration measures.

7. Implement one or more of the following long-term restoration measures, should Daguerre Point Dam not be removed:
   • modify or replace the fish ladders at Daguerre Point Dam with ladders which provide efficient passage over the range of river flows commonly occurring in the river, especially when adult salmonids are migrating;
   • replace existing fish screens on the Hallwood-Cordua and South-Yuba Brophy diversions with structures placed within the river channel, and which incorporate features to minimize juvenile losses to predation, entrainment, and physical injury; and
   • modify the dam spillway to maximize fish ladder efficiency, and to minimize passage problems for adult and juvenile fish.

8. Consult and coordinate with other parties active in habitat management and restoration in the Yuba watershed. The success of Corps efforts to restore fish populations may be amplified or diminished by other actions on the river, such as those affecting river flows or spawning and rearing habitat for salmonids.

9. Collect sediment samples from areas where depositional sediments would be disturbed by restoration measures, and analyze them for presence of contaminants, and for the potential for remobilization. Contaminants could be present in sediments trapped behind Daguerre Point Dam, because extensive gold mining has occurred in the Yuba River watershed, and because contaminants, especially mercury, are often associated with gold processing.

10. The Corps should complete all aspects of Section 7 of the Endangered Species Act of 1973, as amended, including, but not limited to:
   (a) obtain, from the Fish and Wildlife Service, an updated species list for the proposed project area, because the existing one is out of date;
   (b) assess the presence of, and impacts to, threatened and endangered species in the project area. This includes all listed species, with

particular emphasis on bald eagles, valley elderberry longhorn beetle, and winter-run chinook salmon. Should any restoration takes place away from riparian areas, surveys for listed upland plants species would be needed. (c) consult with the National Marine Fisheries Service and California Department of Fish and Game regarding the status of winter-run chinook salmon in the project area.

REFERENCES

Allen, C.K. 1993. Malibu Creek steelhead restoration project: Rindge Dam removal. Text of presentation at 123rd American Fisheries Society annual meeting in Portland, Oregon

CDFG. 1991. Lower Yuba River Fisheries Management Plan. California Department of Fish and Game Stream Evaluation Report No. 91-1.

Cramer, S.P. 1992. Written testimony before the State Water Resources Control Board, Division of Water Rights. Public Hearing on fishery and water rights on the lower Yuba River. February 10, 11, 13, 1992.

Federal Power Commission. 1966. Order Amending License (Major), Project No. 2246, Issued to Yuba County Water Agency. Amends license for New Bullards Bar Dam and other Yuba River water projects.

Hall, F.A., Jr. 1979. An evaluation of downstream migrant chinook salmon (Oncorhynchus tshawytscha) losses at Hallwood-Cordua fish screen. Calif. Dept. of Fish and Game Anadromous Fisheries Branch Admin. Report No. 79-5.

Hallock, R.J. 1983. Effects of Red Bluff Diversion Dam on chinook salmon Oncorhynchus tshawytscha, fingerlings. Calif. Dept. Fish and Game Anadromous Fisheries Branch Office Report.

HDR Engineering, Inc. 1993. Glenn-Colusa Fish Screen Improvements. Phase B: Technical Memoranda.

Jones and Stokes Associates, Inc. 1992a. 1991 Fall run chinook salmon spawning escapement in the Yuba River. Report prepared for Yuba County Water Agency.

Jones and Stokes Associates, Inc. 1992b. 1992 Juvenile chinook salmon monitoring study in the Yuba River. Report prepared for Yuba County Water Agency.

Jones and Stokes Associates, Inc. 1992c. Aerial Survey of the Lower Yuba River. Memorandum to the Yuba County Water Agency. (Note: survey was for spring-run chinook salmon and redds)

Jones and Stokes Associates, Inc. 1992d. SCUBA and snorkeling surveys on the lower Yuba River. Memorandum to the Yuba County Water Agency. (Note: survey, by CDFG personnel and B. Mitchell of Jones and Stokes, was to determine presence of adult spring-run chinook salmon in two reaches below Englebright Dam)

Jones and Stokes Associates, Inc. 1993. Yuba River Juvenile Salmon survey. Series of memoranda to the Yuba County Water Agency.

Jones and Stokes Associates, Inc. 1994. 1992 Fall-run chinook salmon spawning escapement in the Yuba River. Report prepared for Yuba County Water Agency.

Kano, R.M. 1987. The effects of trashrack and bypass design and predator control on predation losses of juvenile chinook salmon at Hallwood-Cordua fish screen. Technical Report No. 14, California Dept. of Fish and Game.

Konnoff, D. 1988. South Yuba-Brophy Diversion Study. Memorandum to Fred Meyer, California Department of Fish and Game Region 2, dated 18 November 1988.

Los Angeles Times. 1994. Are West's dams set in stone? Article in Los Angeles Times, 31 March 1994. Pg. A1.

RCE. 1993. Draft Final Report: Yuba River Basin, California, Project. Geomorphic, Sediment Engineering, and Channel Stability Analyses. Prepared by Resource Consultants and Engineers, Inc., Ft. Collins, CO, for U.S. Army Corps of Engineers, Sacramento, CA

Smith, J. G. 1990. Fishery investigations in the Yuba Goldfields area near Daguerra Point Dam on the Yuba River in 1990. USFWS Report No. AFF1-FAO-90-9. USFWS Fisheries Assistance Office, Red Bluff, CA.

Sumner, F.H. and O. R. Smith. 1939. A biological study of the effect of mining debris dams and hydraulic mining on fish life in the Yuba and American Rivers in California. Report submitted to U.S. District Engineer's Office, Army Corps of Engineers, Sacramento, California.

SWRCB (State Water Resources Control Board). 1991. Staff report on lower Yuba River. SWRB, Division of Water Rights; file no. 363:CFE:262.0.58-08-03

Testimony given at State Water Resources Board Public Hearing Regarding the CDFG's Lower Yuba River Fisheries Management Plan, *In*: United Groups versus Yuba County Water Agency and other water Yuba River water agencies

The Elwha Report. 1993. Restoration of the Elwha River ecosystem and native anadromous fisheries. Public review draft report submitted pursuant to Public Law 102-495. Prepared by: National Park Service in coordination with: USFWS, Bureau of Reclamation, Bureau of Indian Affairs, National Marine Fisheries Service, and Lower Elwha S'Klallam Tribe.

U.S. Fish and Wildlife Service. 1988. Fish passage action program for Red Bluff Diversion Dam. Final Report on Fishery Investigations. Report No. FR1/FAO-88-19. USFWS Fisheries Assistance Office, Red Bluff, CA

U.S. Fish and Wildlife Service. 1990. Yuba River Investigation. Planning Aid Letter prepared for Army Corps of Engineers by USFWS, Ecological Services, Sacramento, CA.

U.S. Fish and Wildlife Service. 1993. Fish and Wildlife Planning Aid Report: Yuba River Basin Investigation. Prepared for Army Corps of Engineers by USFWS, Ecological Services, Sacramento, CA.

U.S. Army COE. 1990. Reconnaissance Report: Yuba River Basin Investigation, California. U.S. Army Corps of Engineers, Sacramento, CA

U.S. Army COE. date unknown. Operation and Maintenance Manual: Yuba River Debris Control Project, Yuba River, California, Daguerre Point Dam. U.S. Army Corps of Engineers, Sacramento, CA

Williams, D.T. 1977. Effects of dam removal: An approach to sedimentation. Technical Paper No. 50. U.S. Army Corps of Engineers; The Hydrologic Engineering Center, Davis, CA

Wilson, J.W., Giorgi, A.E., and L.C. Stuehrenberg. 1991. A method for estimating spill effectiveness for passing juvenile salmon and its application at Lower Granite Dam on the Snake River. Can. J. Fish. Aquatic Sci. 48:1872-1876.

Winter, B.D. 1990. A brief review of dam removal efforts in Washington, Oregon, Idaho, and California. NOAA Technical Memorandum NMFS F/NWR-28. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Wooster, T.W. and R.H. Wickwire. 1970. A report on the fish and wildlife resources of the Yuba River to be affected by the Marysville Dam and Reservoir and Marysville Afterbay and measures proposed to maintain these resources. California Dept. of Fish and Game, Environmental Services Administrative Report No. 70-4.

Appendix A
Federal Agencies' Responsibilities under Sections 7(a) and (c) of the Endangered Species Act

Section 7(a): Consultation/Conference

Requires: 1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species; 2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded, or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after determining the action may affect a listed species; and 3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

Section 7(c): Biological Assessment - Major Construction Activity[1]

Requires Federal Agencies or their designees to prepare a Biological Assessment (BA) for major construction activities. The BA analyzes the effects of the action[2] on listed and proposed species. The process begins with a Federal agency requesting from FWS a list of proposed and listed threatened and endangered species. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the list, the accuracy of the species list should be verified with the Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may proceed; however, no construction may begin.

We recommend the following for inclusion within the BA: an on-site inspection of the area to be affected by the proposal which may include a detailed survey of the area to determine if the species or suitable habitat are present; a review of literature and scientific data to determine species' distribution, habitat needs, and other biological requirements; interviews with experts, including those within FWS, State conservation departments, universities, and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of indirect effects of the proposal on the species and its habitat; an analysis of alternative actions considered. The BA should document the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species will be affected. Upon completion, the BA should be forwarded to our office.

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[1] A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332(2)C).

[2] "Effects of the action" refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action.

APPENDIX B: Chronology of events affecting the lower Yuba River watershed

1853-1909: Hydraulic mining in the upper Yuba drainage removes an estimated 685 million cubic yards of sediment, a volume that would fill a football field to a depth of 77 miles. Most of this washes into the lower Yuba River, raising the river bed higher than the streets of Marysville by 1868. Over time, the river cuts a channel down through the deposited mining debris.
late 1800's-present: Dredging for placer gold in the Yuba Goldfields disturbs roughly 13 square miles of sediment deposits adjacent to the Yuba River, along an 8-mile reach centered near Daguerre Point Dam. Most dredging occurred by mid-1900's, but Yuba Natural Resources Inc. operates one dredge in 1994.
1893: The California Debris Commission (CDC) is formed to prevent further movement of hydraulic mining debris into California rivers.
1904-05: Barrier No. 1 Debris Dam is built by CDC 4.5 miles upstream of Daguerre Point Dam, blocking fish passage until washing out in 1907.
1906: Daguerre Point Dam built by CDC. Crude fish ladders are built, also.
ca. 1911: CDC issues a permit for diversion at Daguerre Point Dam (DPD) to Hallwood and Cordua Irrigation agencies. The permit states that the Federal government is not liable for damage to diversion works or operation caused by dam operation, and that diversion works shall not interfere with Government facilities.
1921: PG&E begins construction on Bullards Bar Dam on North Fork Yuba River, for power generation; no fishways are built to allow fish passage.
1927-28: The fish ladders at Daguerre Point Dam wash out, at least partially.
1938: The fish ladders at Daguerre Point Dam are rebuilt, but are poorly designed; substantial modifications are made to the river's "training levees".
1939: Sumner and Smith report on Yuba River fisheries, recommending the screening all diversions from Yuba River, including Hallwood-Cordua diversion.
1941: Englebright Dam is completed by COE to control mining debris and flooding, about 12.5 miles upstream from Daguerre Point Dam. About 230 feet high, it completely blocks fish passage upstream.
1950: New ladders are installed at Daguerre Point Dam, and passage improves.
1962: Yuba County Water Agency (YCWA) and California Department of Fish and Game (CDFG) sign agreement establishing minimum flows for fish. Minimum flows established at this time remain in effect in 1994.
1963: Daguerre Point Dam and fishways are damaged in February floods.
1964: Within weeks of being rebuilt, DPD and northern fishway and diversion canal are damaged by January floods; reconstruction is finished October 1965.
1969: New Bullards Bar Dam is completed on the North Fork of the Yuba River, by YCWA, for water storage, flood control, and power generation. The dam increases the ability to regulate Yuba River flows. Federal funding (about $18,000,000) for multiple-level water outlets provides control of water release temperature. The old Bullards Bar Dam is inundated.
1972: A fish screen and collection facility is first placed on the Hallwood-Cordua diversion; 1977 modifications reduce losses.
1982: COE modifies fish ladder on north bank to improve function at greater river flows; ladder on south bank not amenable to modification.
1984: South Yuba and Brophy irrigation districts, under agreement with CDFG, construct facilities on the Yuba River's south bank at Daguerre Point Dam, to divert up to 600 cfs; as of 1994 about half this quantity is maximum diverted.
1990: CDFG installs a new fish screen at the Hallwood-Cordua irrigation canal.

APPENDIX C: Individuals and organizations contacted for this study

California Dept. Fish and Game
John Nelson, Fisheries Biologist.
-is currently responsible for lower Yuba River fisheries
Cindy Watanabe, Engineer
-has been lead in Rindge Dam removal project
George Heise; Hydraulic Engineer
-CDFG expert on fish ladders and screens, and on gravel issues.
-provided general input on ladder and screen designs and costs
Fred Meyer, Fisheries Biologist
-worked on Yuba River fisheries for many years, but not currently

National Marine and Sports Fisheries
Marcin Whitman; Fish Passage Engineer; Santa Rosa office.
-expert on fish passage structures; has evaluated fish passage fish passage at Daguerre Point Dam
Chris Mobley; fisheries expert; Santa Rosa office
-expert of status of spring-run of chinook salmon

US Fish and Wildlife Service
Division of Water Resources:
Randy Brown; Fish and Wildlife Biologist; Lewiston suboffice
-has studied Daguerre Point Dam issues; provided input based on work he and Marcin Whitman did on the lower Yuba River
Richard DeHaven; Branch Chief, Corps projects
-has worked on Yuba Goldfields issues, and knows the lower Yuba River
Mark Gard; Fish and Wildlife Biologist
-conducted fisheries research on South Fork of Yuba River
Peter Lickwar; Fish and Wildlife Biologist
-currently working on lower Yuba River, with respect to flow issues
Tom Richardson; Branch Chief, FERC projects
-works on Yuba River fisheries issues
Gary Taylor; Fish and Wildlife Biologist
-provided background on effects of diversions, and alternatives
Northern Central Valley Fishery Resource Office
Jerry Big Eagle: Fisheries Biologist
-made field visit to dam, and provided outline and cost estimates for fisheries studies
Matt Brown: Fisheries Biologist
-worked with Mr. Big Eagle on study design
Richard Johnson: Acting Project Leader
James Smith: Project Leader
-conducted studies on Yuba Goldfields
Division of Habitat Conservation
Michael Thabault; fisheries expert
-until recently worked for NMFS on Central Valley fisheries

U.S. Bureau of Reclamation

Bob Hamilton, Boise, ID office.

-is the Bureau's lead person on studies of removal of Savage Rapids Dam on Rogue River, and of Glines Canyon and Elwha dams on the Elwha River

Consultants

Bill Mitchell; Fisheries Biologist, Jones and Stokes, Inc.

-conducting ongoing studies (1991-1994) of Yuba River fisheries, as consultant to Yuba County Water Agency

Steve Cramer, Independent Consultant

-has consulted and conducted limited fisheries studies on Yuba River for South Yuba-Brophy Irrigation district

University of California, Davis

Dr. Peter Moyle, Dept. Wildlife and Fisheries Biology

-expert on California fisheries, particularly Central Valley

Other Organizations and Individuals

California Sportsfishing Protection Alliance

Bob Baiocchi, Exec. Director

-represents a coalition of many sportsfishing groups, which has been involved in fisheries issues on the lower Yuba River

Friends of the River

Steve Evans: conservation chair, Sacramento office

-organization has no ongoing involvement in lower Yuba R.

Grant's Pass Irrigation District

Dan Shephard

-as manager for the district, has experience with study leading to proposal to remove district's Savage Rapids Dam, and replace dam with pumps

Sacramento River Preservation Trust

John Merz: Chair, Board of Directors.

-group is involved in Sacramento River, but has not focused on Yuba River

South Yuba River Citizens League

Alan Stahler, Board of Directors.

-local organization concerned with Yuba River resource issues; contributed observations of salmon in the Yuba Goldfields channel in 1992 and 1993.

Walter Cook, private citizen, Marysville

-proponent of a parkway along the Yuba River from Englebright Dam to below Marysville; also concerned with Yuba Goldfields issues

APPENDIX D: Sample fish ladder operation guidelines

The guidelines should include the following elements (developed with the help of R. Brown, USFWS, and M. Whitman, NMFS):

1. Determine appropriate flows in ladders for best fish passage.
2. Visit ladders frequently (preferably daily) during adult salmonid migration periods, to monitor and control ladder flows and debris accumulation. Necessary adjustments and cleaning should be performed whenever needed, not once per year.
3. Permanently affix staff gauges to (1) the face of the dam; (2) inside both fish ladders near to the upstream end (i.e., on either side of the gated orifice or ladder exit); (3) the upstream and downstream surface of the entrance (i.e., downstream) orifice for each ladder. Gauges 1&2 will allow calculation of the water volume entering the ladder, when combined with data on size of exit orifice and water surface. Gauges 3 will allow monitoring of attraction discharge at each ladder. To be effective, gauges also should be:
    - placed for easy viewing by maintenance personnel.
    - surveyed and calibrated to a common datum.
4. Maintenance personnel should keep a log of observations and actions at ladders, which includes:
    - staff gauge heights before and after any orifice gate change
    - any major maintenance that needs to be performed
    - any major maintenance that is performed
    - any minor maintenance performed
    - any fish-related observations; e.g., dead fish outside of ladder, large numbers of fish using ladders, or large numbers of fish milling outside a ladder entrance
5. Remove, as soon as practicable, any debris which affects operation of fish ladders or blocks free movement of fish through the ladders. Minor debris accumulations usually do not affect fish movement or ladder operation.
6. Notify State and Federal fisheries agencies in the event that unusual conditions are noted, such as many fish stacked below ladders, or if maintenance should require an extended closure of a ladder during a critical upstream or downstream migration period.
7. Both ladders should not be closed at the same time..

APPENDIX E: Examples of proposed and completed dam removals

Lewiston Dam; Clearwater River, Idaho (tributary to the Snake River)
Dam description: Concrete dam; about 35 feet high, 100 feet long
Agency: Corps of Engineers
Status: Removed in 1973 by cranes, with minimal explosives
Reference: Williams 1977 (analyzes sediment issues)
Costs: unknown

Glines Canyon and Elwha Dams; Elwha River, Olympic National Park, Washington
Dam description: Elwha Dam: concrete; 150 feet high, 450 feet long at crest. Glines Canyon Dam: concrete arch; 210 feet high, 270 feet wide at crest.
Agencies: National Park Service; NMFS; Lower Elwha S'Klallam Tribe
History: The 1992 Elwha River Ecosystem and Fisheries Restoration Act directed the Dept. of Interior to prepare a restoration report of Elwha River ecosystem, and to include a "definite plan" for removing the dams.
Status: Draft restoration report, released Sept. 1993, concludes that removal of dams is feasible, recommended, and would restore ecosystem and fisheries while protecting needs of water users.
References: The Elwha Report, 1993.
Cost estimates (in millions of dollars): Total: $154-210; acquiring dams: $30; dam removal and sediment management: $67-122; protecting water users: $14-15; fish and habitat restoration: $16 million; flood control measures: $2; and partial removal/stabilization of sediments: $67-80.

Point Four Dam; Butte Creek, tributary to Sacramento River, California
Dam description: flashboard dam with concrete apron; abandoned irrigation diversion structure
Agencies: CDFG; Dept. of Water Resources; Western Water Canal District
Status: removed in July 1993, funded by CDFG
Reference: CDFG IFD (Inland Fisheries Division) Monthly Report, July 1993.

Rindge Dam (= Malibu Dam); Malibu Creek, southern California
Dam description: thin arch reinforced concrete; 100 feet high; 95-175 feet wide; 11.5 feet thick at base; built in 1925 for irrigation
Agencies: CDFG, supported by diverse group of agencies and organizations
Status: CDFG is currently studying feasibility of removal.
Reference: Allen, 1993.

Savage Rapids Dam; Rogue River, Oregon
Dam description: about 39 feet high and 380 feet long
Agencies: Grants Pass Irrigation District, Bureau of Reclamation, USFWS.
History: A Bureau of Reclamation study found annual fisheries benefits accruing from dam removal to result in benefit-to-cost ratio of 2.52 to 1. The irrigation district supports dam removal if federal funding can be obtained for removing dam and installing diversion pumps.
Estimated cost: $5 million to remove Dam; up to $6 million to install and power irrigation pumps, buy the dam, and other costs.

Other dam removals are detailed in Winter 1990.

APPENDIX F: Notes on Fish Screen Designs

The following information was gathered during conversations with fisheries biologists and engineers, and from the literature. A particularly thorough discussion can be found in:

HDR Engineering, Inc. 1993. Glenn-Colusa Fish Screen Improvements. Phase B: Technical Memoranda.

Many angled rotating drum screens have been installed in last 20 years in the Pacific Northwest, especially in the Yakima and Umatilla basins. They are generally considered the best available method where there are high debris loads. Most new screens are designed to meet an approach velocity standard of 0.5 feet per second (fps). Generally 0 to 2% of bypassed fish are killed or descaled during passage. However, studies have found that the number of fish recaptured downstream of screens after introduction above rarely exceeds 95%, and is often less than 80%. Causes for loss include predation, passing through seals of screens or over screens, and escape upstream (often juvenile hatchery trout are used in studies, which are reluctant to move downstream). This design has recently been installed in the Tehama-Colusa Canal, at Red Bluff Diversion Dam on the Sacramento River, and has proven very successful; this screen facility was built by the Bureau of Reclamation to handle up to about 3,000 cfs, at cost of about $15,000,000, or $5,000 per cfs.

Angled fixed V-shaped screens have been used by CDFG at many irrigation diversions, and are becoming more common in the Pacific Northwest. The screens are either of perforated plate or wedgewire construction, with powered brushes for cleaning screens of debris. This design is used for flows up to at least 2,200 cfs. A good example for in-channel placement is at Jim Boyd Hydro Project, on the Umatilla River in Oregon.

The "Eicher" modular inclined screen design can function at velocities of up to 3 fps, measured perpendicular to the screen. Recent designs, such as on the Elwha River in Washington, have been successful, with passage survival of 92-99%, depending on fish size (bigger fish-better survival). However, one on the Umpqua River was shut down due to impingement losses. Advantages of this design include relatively low cost, insensitivity to forebay water level fluctuations and icing, and lesser aesthetic impacts at the diversion.

Modular inclined screen construction is used mainly for hydroelectric projects. This design is reported to be flexible over a wide range of intake designs and flows; flows of 50 to 355 cfs were handled at one project. The design can use high (2 to 10 fps) water velocities, and has performed well in laboratory tests.

Attachment 7:
Rindge Dam Removal Study
Bureau of Reclamation
April '95

RINDGE DAM REMOVAL STUDY:

AN EFFORT TO REDUCE THE DECLINE OF THE MALIBU CREEK STEELHEAD TROUT POPULATION IN SOUTHERN CALIFORNIA

APPRAISAL REPORT

April 1995

Prepared by

Bureau of Reclamation
Lower Colorado Region
Boulder City, Nevada

For
California Department of Fish and Game

TABLE OF CONTENTS

CHAPTER 1

SUMMARY

CHAPTER 1: SUMMARY

LOCATION

Malibu Creek drains lands in portions of the Santa Monica Mountains, the Simi Hills, and the Conejo Valley. A number of different slope aspects of the Santa Monica Mountains are included. The watershed is located in Los Angeles and Ventura Counties, some 35 to 50 miles west of downtown Los Angeles. Flowing generally in a southerly direction, Malibu Creek runs through Malibu Creek State Park before emptying into the Pacific Ocean at the beach town of Malibu. The location map (Figure 1, Page 2) provides additional details.

The California Department of Parks and Recreation (Parks and Recreation) owns approximately 10,000 acres, or one-seventh of the watershed, making it the largest landowner. Malibu Lagoon is home to a number of environmentally sensitive animal species and is the subject of a number of ongoing habitat and water quality studies. Malibu Lagoon is one of only two significant coastal wetlands remaining in Los Angeles County.

DESCRIPTION OF AREA

The Santa Monica Mountains rise steeply to the northwest from their base at the ocean shoreline. Periods of intense precipitation and steep side slopes provide opportunity for rapid runoff during the rainy winter and spring seasons. Annual rainfall varies from 12 inches near the coast to 22 inches along the crest of the Santa Monica Mountains. Topography, surface cover, and rapid runoff are features conducive to significant soil erosion and sediment-laden streams.

Historically, flows in the lower reaches of Malibu Creek ceased during dry periods, but some tributaries maintained perennial flows. Discharge from an upstream wastewater treatment plant and irrigation with imported water now supplements the natural flows. Flows as high as 33,000 cubic feet per second have been recorded.

While rainfall can be heavy from October to May, summer and fall months are hot and dry. Temperatures are typical of the southern California coastal areas with mild winters and summer temperatures moderated by on-shore ocean breezes.

The availability of beach-front and ocean-view building sites have contributed to high property values. An affluent community has been built adjacent to Malibu Creek at the upstream edge of Malibu. Residents in this community have an interest in any impacts removal of Rindge Dam might have on the area.

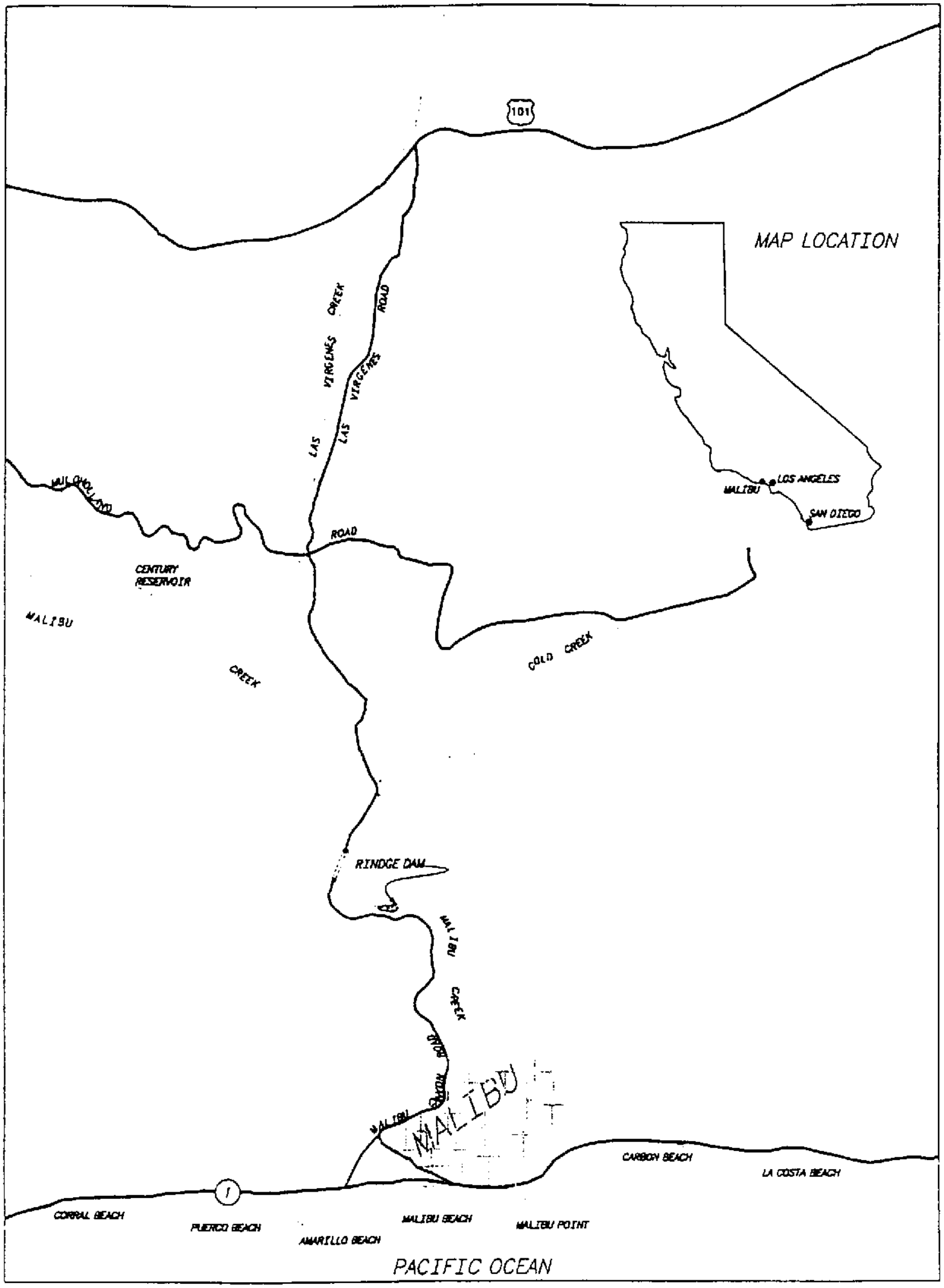
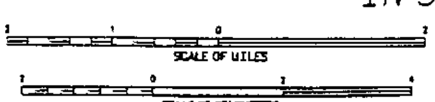


FIGURE 1: LOCATION MAP

RINDGE DAM REMOVAL STUDY
AN EFFORT TO REDUCE THE DECLINE OF
THE MALIBU CREEK STEELHEAD TROUT POPULATION
IN SOUTHERN CALIFORNIA



LEGEND
U.S. ROUTE
STATE ROUTE

DESCRIPTION OF RINDGE DAM

Constructed in a narrow canyon about 2½ miles upstream from the Pacific Ocean, Rindge Dam was built in 1926 to store water for agricultural irrigation on lands along the coast and at the mouth of Malibu Creek. Heavy silt loads in the Creek resulted in sediment deposition in the reservoir. By the mid-1950's, the reservoir was completely filled with sediment. The dam was declared non-jurisdictional by the State of California in 1967. The dam is a concrete arch structure 100 feet high with an arc length of 175 feet at its crest and 95 feet at its base. The thickness of the dam at its crest is 2 feet and 12 feet at its base. It is reinforced both vertically and horizontally with 60 pound per foot railroad rails. A gated spillway was built in a rock outcrop adjacent to the right dam abutment.

The Rindge family, who originally built the dam, sold the property the dam is located on to the State. However, the family still maintains an interest in the structure and its disposition. Although Rindge Dam is on the National Register of Historic Places, the Rindge family has also initiated efforts to designate the dam as historical by Los Angeles County.

The reservoir behind Rindge Dam was originally able to store up to 574 acre-feet of water. Today, the reservoir contains at least 800,000 cubic yards of sediment.

STUDY PURPOSE AND SCOPE

Southern steelhead trout are the most jeopardized of all of California's steelhead stocks. It is thought that Malibu Creek historically supported runs of up to 1,000 adults; presently, the Creek supports a self-sustaining population estimated between 20 and 50 adult southern steelhead. A study (Franklin and Dobush, 1989) has shown that the steelhead trout population could increase threefold if habitat upstream of Rindge Dam could be accessed.

Local fishery interests and the California Departments of Fish and Game (Fish and Game) and Parks and Recreation are among the entities that hope to achieve self-sustaining natural steelhead trout runs in Malibu Creek. In January 1994, Fish and Game requested assistance from the Bureau of Reclamation (Reclamation) to complete an appraisal-level technical evaluation of options for fishery restoration, particularly the removal of Rindge Dam and the sediment behind it. This report contains the results of that effort.

While several alternatives for restoring the fishery are available and some are mentioned in this report, removal of Rindge Dam and the sediment behind it was emphasized during the study. Reclamation only addressed technical alternatives for dam and sediment removal and costs of those alternatives. No attempt was made to evaluate biological resources, determine impacts upon them, or estimate costs for any mitigation measures that may be necessary.

ALTERNATIVES CONSIDERED

Three methods of dam and sediment removal were considered. One alternative consists of removing the dam and sediment from Malibu Canyon through mechanical means. Sediment and dam rubble would be hauled out of the canyon to an undetermined disposal site. Another alternative would involve moving the sediment downstream to an engineered landfill site along the Creek. The third alternative would entail removing the dam in segments and allowing natural Creek flows to move sediment downstream. Each alternative is described in detail in the following chapters.

Other options for promoting the re-establishment of steelhead trout access to habitat upstream of the dam have been considered by other agencies. Fish ladders, lifts, and flumes; a V-notch in the top of the dam; hydraulic dredging (natural and artificial); and a V-section on one side of the dam were all considered, but were not pursued. These alternatives, along with the reasons for their elimination, are briefly addressed in this report.

During the course of this preliminary investigation it became apparent that there was a discrepancy on the amount of sediment deposited behind Rindge Dam. Reclamation originally calculated a quantity of about 1,600,000 cubic yards, while a State contractor estimated a quantity of 801,500 cubic yards. A description of Reclamation's computation methodology and a comparison with the contractor's numbers are included in the Appendices.

Although the volume of sediment is critical to determining an accurate cost estimate, existing data are inadequate to provide a specific quantity with appropriate confidence. Given this dilemma, one of several approaches could be taken. The high number could be used to provide an upper limit to estimated project costs; a number in the middle of the range could be used as a reasonable average; or the low number could be used because actual on-site drilling has supported calculations that led to that estimate.

At the request of Fish and Game, the lower number was used in this report. Reclamation drawings and calculations were adjusted to accommodate this request. However, this adjustment does not constitute Reclamation's endorsement of the lower number. The discrepancy points out the necessity of additional field investigation and verification. If the project is pursued, Reclamation recommends a more detailed engineering effort, including a task specifically designed to verify the sediment quantity.

CHAPTER 2

ALTERNATIVE #1

MECHANICAL REMOVAL OF DAM AND SEDIMENT FROM THE CANYON

CHAPTER 2: ALTERNATIVE #1

MECHANICAL REMOVAL OF DAM AND SEDIMENT FROM THE CANYON

DESCRIPTION

This alternative consists of mechanical removal of the dam and all sediment deposited in the reservoir. A temporary haul road into the canyon upstream of the dam would be constructed. To divert flows away from the construction site, a temporary cofferdam and bypass pipeline would be constructed. After blasting the dam in segments, concrete and sediment would be hauled to an off-site disposal.

The temporary haul road would be built at a 6 to 8 percent grade from Malibu Canyon Road to the top of the existing sediment. This access road would be widened where it connects to Malibu Canyon Road to improve the access of equipment and to allow a greater turning radius for haul trucks. The amount of widening would depend on the type of equipment used for construction and the direction the trucks turn onto the road.

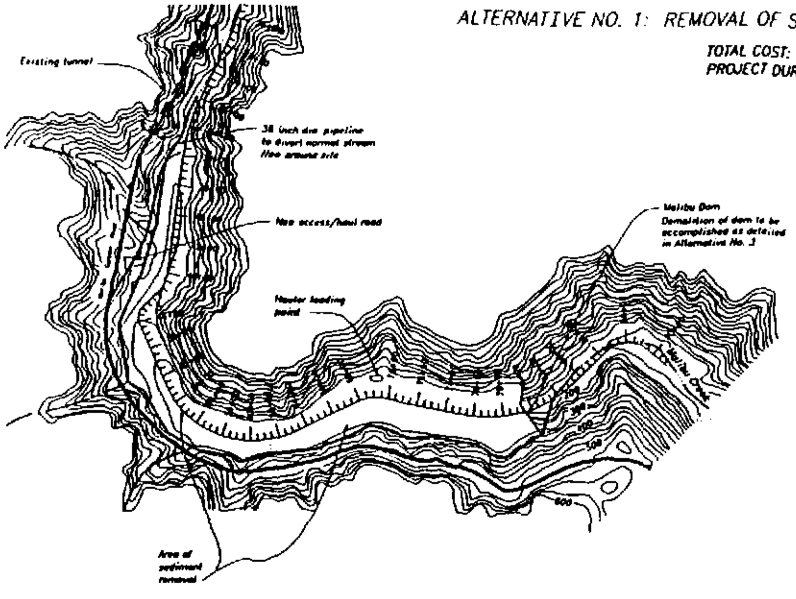
A temporary cofferdam would prevent stream flows from entering the construction site. A pipeline would convey diverted flows around the construction site along the side of the canyon closest to Malibu Canyon Road and discharge water over the spillway. The pipeline would consist of a 36-inch-diameter corrugated metal pipe with a thrust block constructed at each bend to resist forces. Drawing No. X-LC-214 (Page 6) shows the proposed location of the haul road and diversion pipeline.

The dam would be removed by blasting in 10-foot lifts, or vertical segments. A trench would be excavated along the upstream face to a depth of 20 feet. The trench would be 10 feet wide at the base and slope back to daylight at a slope of 1:1 (1 foot horizontal to 1 foot vertical). Holes would be drilled into the dam at an angle as shown on Drawing No. X-LC-217 (Page 7) to blast the appropriate lift. The concrete blocks would fall into the excavated trench for removal by the contractor. The contractor would be required to minimize the amount of concrete and rubble falling down the face of the dam. Any reinforcement (i.e., railroad rails) would be removed by cutting and hauling to an approved landfill.

It is anticipated that the contractor would use self-loading scrapers and bulldozers to transport sediment to a movable conveyor belt to fill bottom-dump trucks. Restrictions at the site would necessitate the use of smaller than normal self-loading scrapers, (i.e., 11 cubic yard capacity). The self-loading scrapers would excavate sediment and pile it at a point near the center of mass of the sediment as shown on Drawing No. X-LC-214 (Page 6). Bullldozers would separate larger rocks from the pile and push the remaining material into a movable conveyor belt feeder. The sediment would then be conveyed to trucks to be hauled out of the canyon, via the temporary haul road, to a designated disposal site.

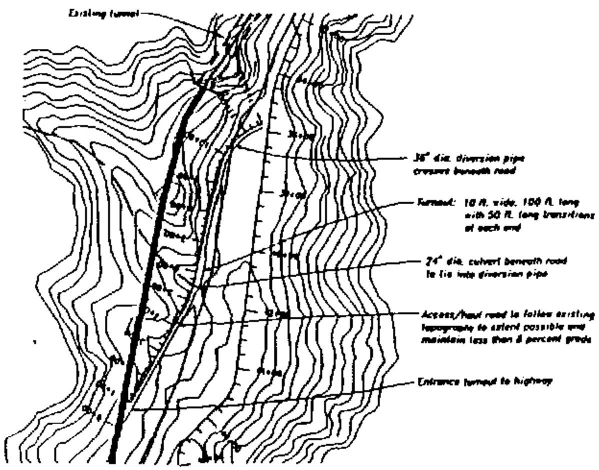
ALTERNATIVE NO. 1: REMOVAL OF SEDIMENT BY EXCAVATION AND HAULING

TOTAL COST: $17,500,000
PROJECT DURATION: 2 YEARS

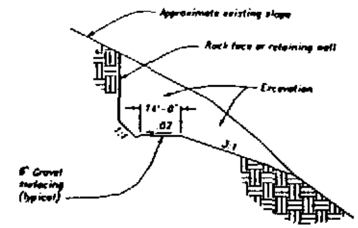


PLAN

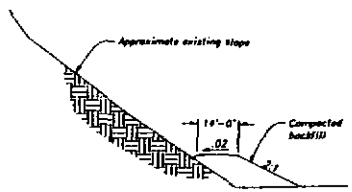
SCALE OF FEET



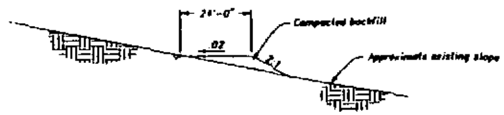
PLAN AT ACCESS/HAUL ROAD



TYPICAL SECTION FROM STA. 0+00 TO TURNOUT AT STA. 5+00



TYPICAL SECTION FROM TURNOUT AT STA. 7+00 TO STA. 11+83.85



TYPICAL SECTION AT TURNOUT FROM STA. 5+00 TO STA. 7+00

CROSS SECTIONS AT ACCESS/HAUL ROAD

PROS

- Excavation and hauling are established construction methods
- Maintains dependable water supply to fish downstream with no increased turbidity
- In the event there is a threat of flooding, the Contractor may remove his equipment to the access/haul road

CONS

- Most expensive of the alternatives
- Considerable disruption to traffic on Malibu Canyon Highway
- Need to locate disposal sites for 0.8 million cubic yards of sediment
- The access/haul road will need to be repaired each season

PROJECT SEQUENCE

1. Construct new access/haul road.
2. Install diversion pipe.
3. Clear vegetation from the sediment in the reservoir area.
4. Core drill through base of the dam and install drains to dewater sediment in the reservoir area.
5. Demolish the dam in lifts.
6. Excavate the sediment in lifts as the dam is removed.
7. Rehabilitate the reservoir area.

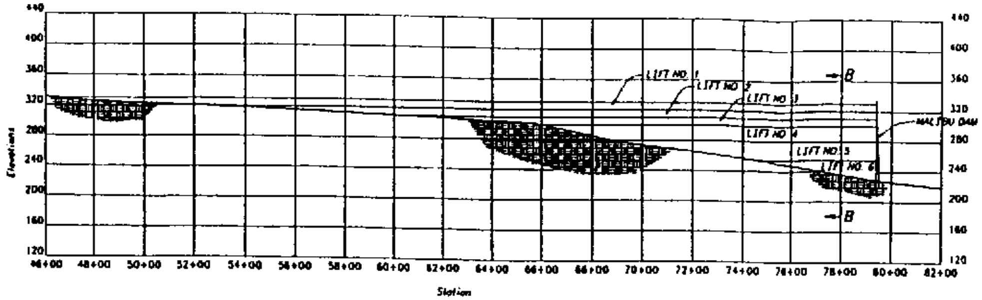
ALWAYS THINK SAFETY

CALIFORNIA – MALIBU

ALTERNATIVE NO. 1
EXCAVATION OF SEDIMENT
PLAN AND SECTIONS

ALTERNATIVE NO. 3: REMOVAL OF SEDIMENT BY STREAM EROSION

TOTAL COST: $4,000,000
PROJECT DURATION: 8 TO 18 YEARS



PROFILE

℄ MALIBU CREEK

PROS

Least expensive of the alternatives

Simplest alternative from a construction standpoint

Sediment would have naturally washed downstream and into the ocean if the dam was not present

CONS

Duration of project dependent on unpredicable flows each year

Might have to remove sediment from downstream areas if it does not wash all the way out to the ocean

Increased turbidity downstream

Alternative requiring the longest duration before the stream is restored

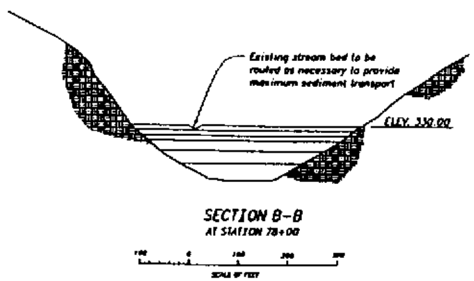
The area at the base of the dam and immediately downstream will fill with sediment for the duration of the project

There could be an increased chance of downstream flooding due to loss of the creeks cross-sectional area as a result of sediment deposition. The run of steelhead trout may be wiped out if all their rearing pools are eliminated.

PROJECT SEQUENCE

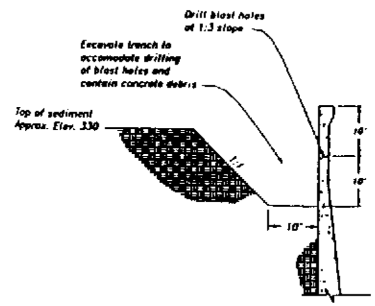
1. Recondition existing access road.
2. Excavate a trench along the upstream face of the dam.
3. Demolish the dam in lifts by blasting.
4. Clear vegetation from the sediment in the reservoir area.
5. As each sediment layer is removed, the stream shall be rerouted as necessary to provide maximum sediment transport.

VOLUME OF SEDIMENT BY LIFT		
LIFT NO	LIFT ELEVATION	VOLUME (cu. yds.)
1	320 - 330	176,630
2	310 - 320	160,400
3	300 - 310	149,000
4	280 - 300	143,920
5	255 - 280	114,960
6	230 - 255	56,590
	TOTAL:	801,500



SECTION B-B

AT STATION 78+00



SECTION

REMOVAL OF TOP 10' OF DAM

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CALIFORNIA – MALIBU
RINDGE DAM REMOVAL

ALTERNATIVE NO. 3
SEDIMENT REMOVAL BY STREAM EROSION
PROFILE AND SECTIONS

X-LC-217

SEDIMENT QUANTITY

Fish and Game contracted with Law/Crandall, Inc. to conduct a geological investigation of the sediment located behind Rindge Dam (Law/Crandall, 1993). From this study, Law/Crandall estimates that there is 801,500 cubic yards of sediment.

DISPOSAL OF MATERIAL

The following three sites were identified as potential locations for disposing sediment:
1) Malibu beaches located approximately 2 miles from the project site; 2) Calabasas Landfill located approximately 10 miles from the project site; and 3) a fill site approximately 1 mile downstream from the dam.

If the material meets sand specifications (material containing 70% sand or better), the California Coastal Commission prefers that the portion of sediment classified as such be used for beach nourishment. However, to use the material for this purpose, permits from the California Coastal Commission and the Army Corps of Engineers must be obtained. The concept of using the sediment for beach nourishment is ideal because material at an unwanted site (Malibu Creek) would be moved to a site which would greatly benefit from the material (Malibu beaches). Based upon the geological report completed by Law/Crandall, the chances of using sediment located behind Rindge Dam for this purpose are very good. The table below (reproduced from the Law/Crandall report) presents the estimated volume and percentage of the total volume for each material type:

MATERIAL VOLUMES		
SEDIMENT TYPE	VOLUME (yd^3)	% TOTAL
Silt and Clay	123,000	16
Silty Sand and Sandy Silt	276,000	34
Sand and Gravel	339,000	42
Cobbles and Boulders	63,500	8
Total Volume	801,500	100

The Calabasas Landfill has confirmed that it will currently accept the material at a rate of $22.24 per ton, but this figure is likely to change as the amount of mud slide waste material in the area decreases. Eventually, the landfill will accept fine clay material from the reservoir site at no cost to be used as a protective cover for refuse. As shown above, Law/Crandall estimates 123,000 cubic yards of material will be available that is suitable for protective cover. Disadvantages of this site are that current charges make disposal very expensive and its remote location increases transportation costs.

COSTS

Costs associated with this alternative are listed by line items on Table 1 (Page 10). At the bottom of the table, the item identified as "Additional items (+10%)" accounts for items not listed because they have minimal impact to the overall estimate. The item "Unknown contingency (+ approx. 25%)" accounts for items not estimated due to the preliminary nature of this proposal versus a final design. Table 2 (Page 11) provides supporting information used to arrive at the costs generated in Table 1.

The cost estimate in Table 1 is based upon Law/Crandall's estimated quantity of 801,500 cubic yards of sediment. Using this sediment volume, the estimated total costs would be $17.5 million.

Two major locations were considered during this effort—the Calabasas Landfill and Malibu Beach. The two locations have an 8-mile hauling difference. The cost estimate given in this report reflects the longer hauling distance, which is the Calabasas Landfill location. If Malibu Beach, located approximately 2 miles from the construction site, becomes the actual location for sediment disposal, the revised cost estimate would be $11 million. The most attractive scenario, then, is a sediment volume of 801,500 cubic yards transported to Malibu Beach for beach nourishment.

Other beach sites south of Malibu are experiencing serious erosion problems and may be more appropriate locations for beach nourishment operations than Malibu beaches. Use of these sites should be investigated further during more detailed studies.

CONSTRUCTION IMPLICATIONS

Removal of sediment by excavation and hauling would create traffic congestion and delays on Malibu Canyon Road. For purposes of this study, sediment hauling was assumed to be limited to the hours of 9 a.m. to noon and 1 to 4 p.m. to minimize traffic interference. Because of this restriction, the estimated time to complete the project is 2 years. Actual construction hours may expand during certain periods of the year or during weekends. In that event, the construction period would be shortened.

After removing sediment and dismantling the dam, significant amounts of vegetation would be lost in what is now the reservoir area. Re-establishment of riparian vegetation along the streambed would be required. Nuisances occurring during construction could be dust and noise from equipment, which could be managed to minimize their significance.

TABLE 1: COST ESTIMATE FOR ALTERNATIVES

AMOUNT in $1,000's

ITEM	WORK OR MATERIAL	QUANTITY/UNIT	UNIT PRICE	ALT#1	ALT#2	ALT#3
1	Mobilization & prep work	For the lump sum of		1,100	606	443
2	Clearing	32 / acre	725.00	23.2	23.2	23.2
3	Water for dust abatement	For the lump sum of		250	250	
4	Construct Access/haul road	For the lump sum of		300		
5	Dewatering sediment in reservoir area	For the lump sum of		750	750	
6	Demolition of dam	4,200 / cubic yard	50.00	210	210	210
7	Remove, haul, dispose of concrete waste	4,200 / cubic yard	10.00	42	42	42
8	Furnish and install diversion pipe	5,000 / linear foot	46.00	230	230	
9	Excavate sediment	801,500 / cubic yard	2.38	1,907.6	1,907.6	
10	Haul sediment	801,500 / cubic yard	9.24	7,405.9		
11	Maintain access/haul road	801,500 / cubic yard		43.3		
12	Mitigation at landfill site/rehab at reservoir	For the lump sum of		500	500	
13	Recondition access road	For the lump sum of			200	200
14	Construct maint. road	For the lump sum of				2,000
15	Install conveyor system	For the lump sum of			3,000	
16	Conveyor system O&M	2,400,000 / ton	.24		600	
17	Prep engineered landfill site	For the lump sum of			1,000	

	ALT#1	ALT#2	ALT#3
SUBTOTAL	12762.0	9318.8	2918.2
Additional Items (+ 10%)	1276.2	931.9	291.8
TOTAL FOR SCHEDULE	14038.2	10250.7	3210.0
Unknown contingency (+ Approx 25%)	3461.8	2549.3	790.0
TOTAL ESTIMATED COST	17,500	12,800	4,000

TABLE 2: SUPPORTING INFORMATION FOR COST ESTIMATES

ITEM	COMMENTS	Ref.
Mobilization and preparatory work	The Contractor is paid to bring equipment to the site and set up construction operations.	
Clearing	It is necessary to remove vegetation before construction operations begin. Estimated equipment needed for this task includes a dozer with ball and chain.	(1)
Water for dust abatement	Water is applied to dry soil to keep undisturbed dust particles from entering the atmosphere. Water trucks are needed for this operation. (Average of bids for similar projects were used.)	(3)
Construction access/haul roads	Access/haul road is required to access the construction site. (Insufficient topography information for detailed estimate; therefore, the cost for this item was inferred from difficulty of terrain in the area.)	
Dewatering sediment in reservoir area	Water must be removed from the sediment before the contractor can remove the material from the reservoir. (Geology report not available at time estimate was prepared, cost based on a proposed system of horizontal drains through the base of the dam into sediment in the reservoir area.)	
Explosive demolition of dam	The dam will be removed in segments by blasting. (Cost was based upon a previous bid item cost to blast the south tailrace retaining wall at Headgate Rock Dam.)	
Remove, haul, dispose of concrete waste	Disposal of concrete blocks from excavated trench and hauling to a predetermined disposal site. The cost was slightly increased to incorporate a long haul distance. (The haul distance was assumed to be 10 miles.)	(1)
Furnish & install diversion pipe	36-inch piping will be used to divert river flows around the construction site to allow the contractor to work in dry conditions. (The costs assume piping, storm drainage, corrugated metal, 36" diameter, 12 gauge.)	(1)
Excavate sediment	To excavate the sediment from behind the dam, it was assumed that the contractor would use an elevating scraper with a capacity of 11 cubic yards and a haul distance limited to 1500 feet.	(1)
Haul sediment	To haul sediment out of Malibu Canyon, a 16.5 cubic yard bottom dump trailer was used, assuming a 10-mile round trip journey. (The price was increased by 17 percent for medium traffic along Malibu Canyon Road.)	(1)
Maintain access/haul road	To continue access into and out of Malibu Canyon, the contractor will need to maintain the access/haul road by motor graders. (The cost was based upon a 1978 cost of $0.027 per cubic yard x 801,500 cubic yards = $21,640.50. Double the estimates for flooding repairs and 1994 costs.)	(2)
Additional items	Minor items not covered in these estimates because individually they have minimal impact on the Total Estimated Cost.	
Unknown contingency	Items not accounted for in these estimates due to preliminary nature of proposals versus final designs.	
Mitigation and rehabilitation at reservoir area	Following construction, the contractor will be required to rehabilitate the reservoir area. it is unknown at this time the extent of reservoir area rehabilitation required; therefore, a lump sum value was assumed. Should this amount be insufficient, the money set aside under the unknown cost would cover the remaining amount of money required.	

REFERENCES USED IN TABLE 2

(1) 1994 Means Heavy Construction Cost Data
(2) Excavation Handbook by Horace K. Church
(3) Abstract of ~~[illegible]~~ for Salt-Gila Aqueduct Reach 4 project
bids

CHAPTER 3

ALTERNATIVE #2

ENGINEERED LANDFILL IN MALIBU CANYON

CHAPTER 3: ALTERNATIVE #2

ENGINEERED LANDFILL IN MALIBU CANYON

DESCRIPTION

This alternative consists of mechanically excavating material behind the dam and transporting it downstream to an engineered fill in Malibu Canyon. The existing access road to the construction site would be reconditioned and a temporary cofferdam and bypass pipeline would be constructed to divert river flows. A conveyor belt system would be used to transport material to the fill site. The dam would be dismantled by blasting and the resulting rubble would be hauled out of the canyon.

The conveyor system would begin at a sediment removal site just upstream of the dam. The first section of the conveyor system would be built on a steep incline up the canyon to the Malibu Canyon Road. The conveyor would then follow the road to the fill site. This would permit construction and maintenance without the need for a new temporary road.

The access road into the canyon above the dam would need to be widened where it connects to Malibu Canyon Road to improve access for equipment. The amount of widening would depend on the type of equipment used during construction.

A temporary cofferdam would prevent stream flows from entering the construction site. A pipeline would convey diverted flows around the construction site along the side of the canyon closest to Malibu Canyon Road and discharge water over the spillway. The pipeline would consist of one 36-inch-diameter corrugated metal pipe with a thrust block constructed at each bend to resist forces. Drawing No. X-LC-215 (Page 13) shows the proposed location of the haul road and diversion pipeline.

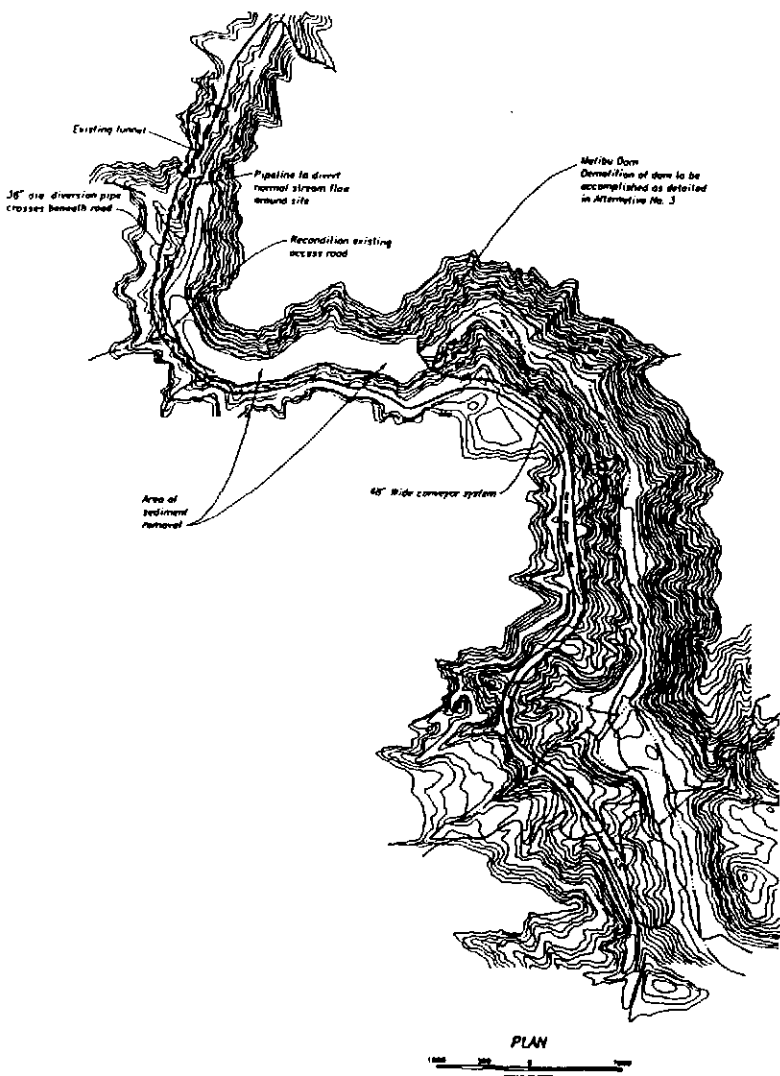
The dam would be removed by blasting in 10-foot lifts. A trench would be excavated along the upstream face to a depth of 20 feet. The trench would be 10-feet wide at the base and slope back to daylight at a slope of 1:1 (1 foot horizontal to 1 foot vertical). Holes would be drilled into the dam at an angle as shown on Drawing No. X-LC-217 (Page 7) to blast the appropriate lift. The concrete blocks would fall into the excavated trench for removal by the contractor. The contractor would be required to minimize the amount of concrete and rubble falling down the face of the dam. Any reinforcement (i.e., railroad rails) would be removed by cutting and hauling to an approved landfill.

A conveyor belt system would be constructed from the dam to an approved engineered fill site. Self-loading scrapers and bulldozers would be used to transport the sediment to a conveyor belt feeder. Large rocks would be separated from the material before feeding it into the conveyor belt. At the engineered fill, the sediment would be spread by bulldozers and compacted with water trucks and sheeps-foot rollers to achieve optimum compaction.

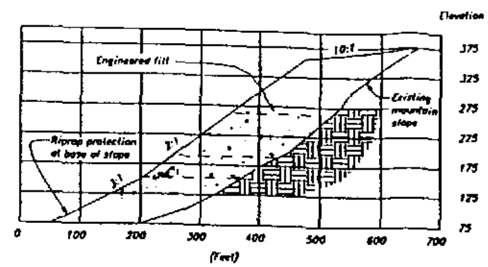
X-LC-215

ALTERNATIVE NO. 2: EXCAVATE AND CONVEYOR SEDIMENT TO ENGINEERED LANDFILL

TOTAL COST: $12,800,000
PROJECT DURATION: 1 YEARS



PLAN



TYPICAL SECTION THROUGH ENGINEERED LANDFILL SITE

PROS

Shortest project duration of the alternatives

Minimal disruption to highway traffic

Maintains dependable water supply to fish downstream with no increased turbidity

CONS

Alteration to downstream terrain due to engineered landfill site

Difficult to install conveyor system

PROJECT SEQUENCE

1. Construct conveyor system.
2. Recondition existing access road to reservoir area.
3. Install diversion pipe.
4. Core drill through base of dam and install drains to dewater sediment in reservoir area.
5. Prepare engineered landfill site to receive sediment.
6. Demolish dam in lifts.
7. Conveyor sediment to landfill sites as dam is removed.
8. Perform mitigation at landfill sites and rehabilitate reservoir area.

ALWAYS THINK SAFETY

ALTERNATIVE NO. 2
EXCAVATE AND CONVEYOR SEDIMENT TO ENGINEERED LANDFILL
PLAN AND SECTION

X-LC-215

Following its completion, the engineered fill would be landscaped to match the natural conditions of the immediate area. Larger rocks removed from the sediment would be placed on the slope for erosion protection and natural vegetation (trees, grasses, and shrubbery) would be planted to enhance the appearance of the site.

DISPOSAL OF MATERIAL

Two potential locations have been selected for placing an engineered fill downstream of the dam. The first location is approximately ¾ of a mile downstream; the second location is approximately 1¼ miles downstream. Because these two locations have gentle slopes and large enough areas to easily blend material into the hillside, the engineered fill could be made—with proper re-vegetation and earth placement—to look like a natural land form. The slope of the engineered fill would begin at 3:1 (3-feet horizontal to 1-foot vertical), transition to 2:1, and top out at a 10:1 slope. The base of the fill would be protected by large rocks and, to control drainage, mid-size rocks would be placed to form natural appearing channels. Anticipated landfill placement sites are subject to the California Coastal Act and, as they are also within the State Park boundaries, would require State approval.

COSTS

The costs associated for this alternative are listed by line item on Table 1 (Page 10). Table 2 (Page 11) provides supporting information used to arrive at the costs generated in Table 1.

Cost estimates given in Table 1 (Page 10) are based on the Law/Crandall sediment volume estimate of 801,500 cubic yards. The cost estimate for an engineered landfill in Malibu Canyon is $12.8 million.

CONSTRUCTION IMPLICATIONS

Removal of sediment by excavation and conveying the material to an engineered fill would cause minimal disruption to traffic on Malibu Canyon Road. An added benefit is that construction can continue for longer periods of time, (i.e., 10- to 12-hour work days as opposed to 6-hour work days) due to hauling limitations on the road. The estimated time to complete the project is 1 year.

Since construction would cause a significant loss of vegetation in the reservoir area, re-establishment of riparian vegetation along the streambed would be required. After project completion, the conveyor system would be removed and this area restored to natural conditions. To minimize environmental disruption and alleviate the need for an access road in the lower reaches of the canyon, compaction, earth moving, and rock placement equipment would be winched down to the fill site from Malibu Canyon Road. Nuisances occurring during construction could be dust and noise from equipment, but these could be managed to minimize their significance.

Disposal at a site within the canyon downstream of the dam would require coordination with a variety of Federal, State, and local agencies. This option is less expensive and involves less time to complete than other disposal options, but it comes with more environmental and aesthetic concerns.

CHAPTER 4

ALTERNATIVE #3

REMOVAL OF SEDIMENT BY STREAM EROSION

CHAPTER 4: ALTERNATIVE #3

REMOVAL OF SEDIMENT BY STREAM EROSION

DESCRIPTION

Under this alternative, the dam would be removed in 6 lifts over a number of years and sediment behind the dam would erode under natural stream flow. After each lift, construction equipment would demobilize from the canyon and the stream would be directed toward the dam. Natural flows would transport the sediment downstream. Berms would be constructed to divert flows away from construction crews.

To move equipment into the canyon for dam removal, the existing access road would be reconditioned. The access road would be widened where it connects to Malibu Canyon Road to allow haul trucks a wider turning radius. The amount of widening would depend on the type of equipment used in construction.

Temporary berms would be constructed with sediment excavated from behind the dam to divert river flows. River flows must be diverted so construction crews removing the dam can work in dry conditions. After removal of half a lift, the river would be diverted to the opposite side while the workers remove the remaining half of the dam. Drawing No. X-LC-216 (Page 17) shows the project location.

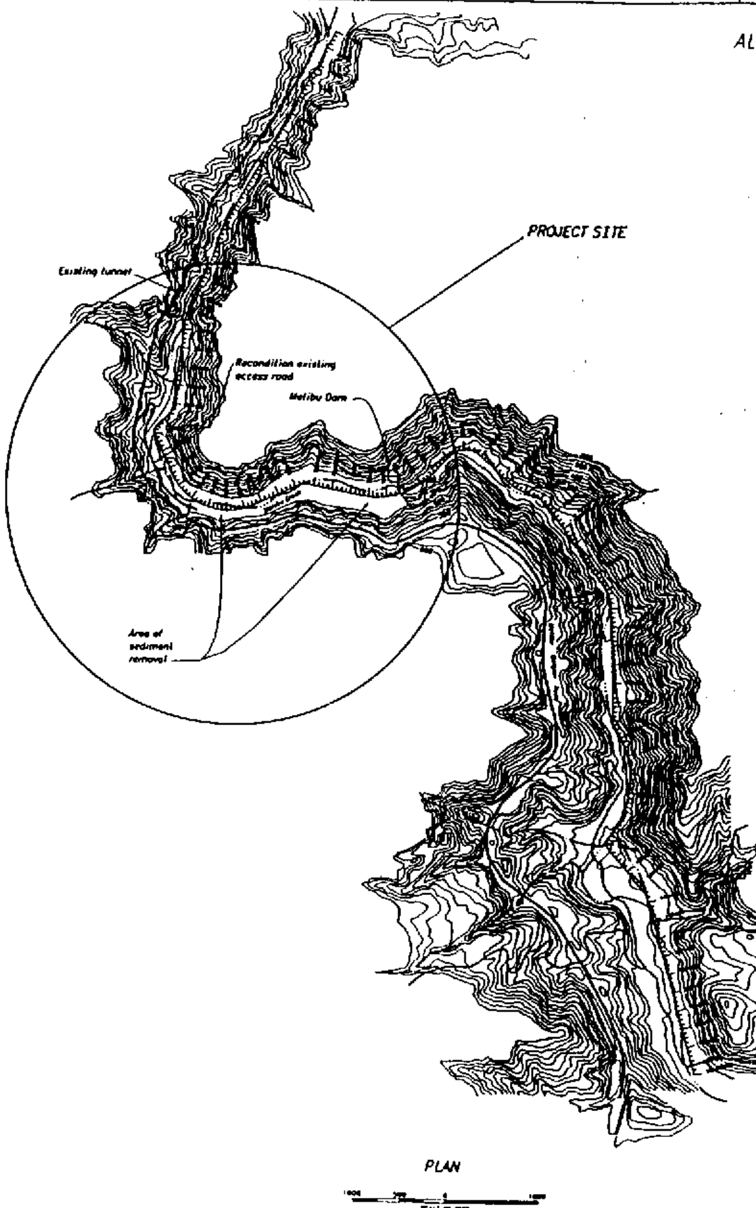
The dam would be removed by blasting in 6 lifts. A trench would be excavated along the upstream face to a depth 10 feet lower than the height of the lift as described by Drawing No. X-LC-217 (Page 7). The trench would be 10 feet wide at the base and slope back to daylight at a slope of 1:1 (1 foot horizontal to 1 foot vertical). Holes would be drilled at an angle as shown on Drawing No. X-LC-217 (Page 7) to blast the appropriate lift. The concrete blocks would fall into the excavated trench for removal by the contractor. The contractor would be required to minimize the amount of concrete and rubble falling down the face of the dam. Any reinforcement, (i.e., railroad rails) would be removed by cutting and hauled to an approved landfill.

DISPOSAL OF MATERIAL

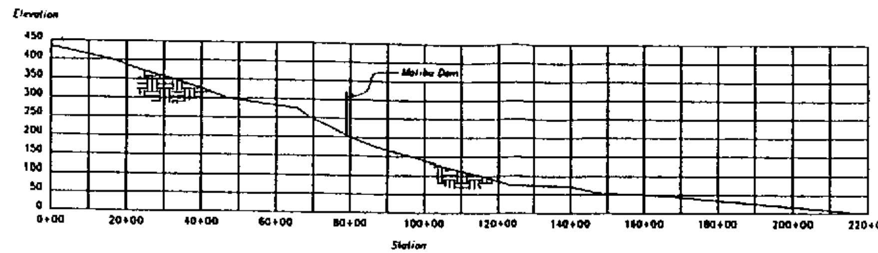
This alternative requires natural stream flows to transport sediment to the ocean. If flows do not remove all the reservoir sediment in a lift, the stream wouild be rerouted to dislodge the remaining sediment. It is possible that not all the sediment would move into the ocean, creating depositional bars in the lower stretch of the river. A previous sediment transport analysis (Trihey, 1989) verified the possibility of pools being filled by sediment when high flows are carrying significant sediment loads. Additional sediment transport work would be necessary to clarify potential impacts of this alternative.

ALTERNATIVE NO. 3: REMOVAL OF SEDIMENT BY STREAM EROSION

TOTAL COST: $4,000,000
PROJECT DURATION: 8 TO 18 YEARS



PLAN



GROUND PROFILE THROUGH MALIBU CANYON
FROM STA. 0+00 TO OCEAN

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CALIFORNIA – MALIBU
RINDGE DAM REMOVAL

ALTERNATIVE NO. 3
SEDIMENT REMOVAL BY STREAM EROSION
PLAN AND PROFILE

X-LC-216

COSTS

Costs associated with this alternative are listed by line items on Table 1 (Page 10). Table 2 (Page 11) provides supporting information used to arrive at the costs generated in Table 1 (Page 10).

Costs given in Table 1 (Page 10) are based on Law/Crandall's sediment volume estimates of 801,500 cubic yards. The cost estimate for removal of sediment by stream erosion is $4 million.

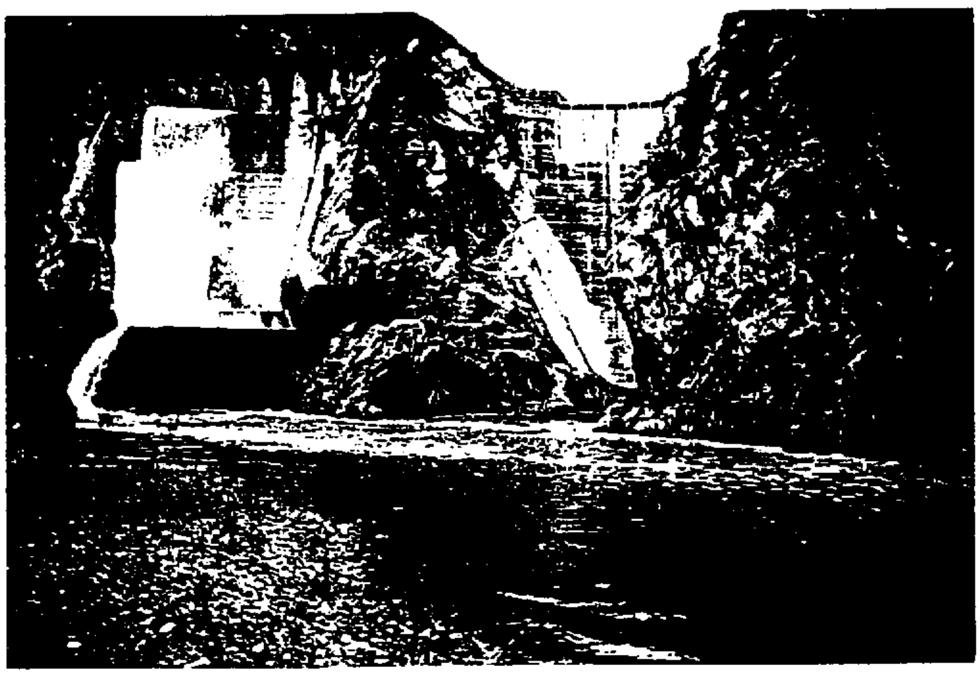
CONSTRUCTION IMPLICATIONS

This sediment removal method could result in sediment accumulation in downstream pools that would have to be removed by mechanical methods. Elevated stream sediment loads could also impact aquatic species and, at this time, it is unknown whether the aquatic life could withstand the changes caused by stream sediment transfer.

Construction costs to remove portions of the dam would be minimal, resulting in a low cost estimate for this alternative. However, the project duration would range between 8 to 18 years depending upon natural hydrology. Dust and noise pollution would only occur during actual construction and would not significantly impact local residents.

CHAPTER 5

OTHER ALTERNATIVES



CHAPTER 5: OTHER ALTERNATIVES

The following alternatives were considered but not pursued for the reasons listed below. The benched flume and the hydraulic dredge and slurry operation were developed by Reclamation: the remaining options were previously developed and considered by Fish and Game.

HYDRAULIC DREDGE AND SLURRY

One option for removing sediment behind the dam is to use a hydraulic dredge to remove the material and pump it to another location.

Hydraulic dredging requires a dredging machine to operate in a streambed with continuously flowing water. The machine moves the saturated sediment to a pipeline where additional water is added to make a slurry that is transported to a disposal site. The key to this operation is having enough water to dredge and slurry the sediment to a disposal site. Malibu Creek does not have the required flows for both this operation and the maintenance of downstream aquatic life; therefore, this alternative was eliminated from further consideration.

FISH LADDERS

A Borland fish lift and a benched flume were considered for transporting native steelhead trout upstream for spawning. Primary reasons these alternatives were eliminated from further consideration included: 1) operation and maintenance required at a time when it would be unsafe to access the facilities; 2) earthquakes, rock, and debris slides would require constant reconstruction of the structures; and 3) difficulty in achieving site access for construction, maintenance, and operation.

OTHER NATURAL EROSION OPTIONS

Several options were considered for removal of sediment through "natural" erosion in addition to "Alternative #3, Removal of Sediment By Stream Erosion". One of these options was to allow stream erosion through a V-notch cut into the dam, rather than removing the entire dam. And, in an effort to accommodate the historical perspective of the dam, Fish and Game considered the option of cutting a hole in the base of the dam to create a more natural stream flow condition without removal of the dam.

Each of these proposals had the unfortunate potential for creating irretrievable harm to the existing fish habitat between the dam and the creek mouth. In addition, the logistics of removing sediment through a hole in the dam base and the high variability of flows create conditions that make it difficult to implement such an option without jeopardizing the structural integrity of the dam.

CHAPTER 6

ALTERNATIVE EVALUATION

CHAPTER 6: ALTERNATIVE EVALUATION

THEORY

The preceding chapters presented several alternatives for removal of Rindge Dam and sediment in the reservoir. This chapter describes the method used to determine a relative ranking among the alternatives.

The method used here makes use of two tools—the Paired Comparison Matrix and the Analysis Matrix. The Paired Comparison Matrix is used to determine the order of importance of a list of evaluation parameters, while the Analysis Matrix is used to determine the order of preference of a number of solution alternatives.

The first step in the evaluation process is to define a list of parameters that are used to evaluate the alternatives. Some of these parameters are, no doubt, more important than others. To determine that relationship, each parameter is compared with the others. The comparison determines which parameter is more (or less) important than the other and by how much. If there are only two parameters, the problem is minimal, but when the list of parameters is long, the Paired Comparison Matrix can help keep the process straight.

As an example of how this is done, consider a problem with two alternative solutions and three evaluation parameters. Assume the three evaluation parameters are:

PARAMETER IDENTIFICATION LETTER	PARAMETER
A	color
B	price
C	speed

When color and price are compared, price is determined to be <u>much</u> more important. So, on a random scale of 1 to 4, price would be given a score of 4. When color and speed are compared, speed is determined to be more important by a score of 3. Comparing price to speed results in price being more important by a score of 2. A Paired Comparison Matrix with these parameters would look like this:

	B: Price	C: Speed	Subtotal	Ranking
A: COLOR	B4	C3	0	3
B: PRICE		B2	6	1
C: SPEED			3	2

The letter shown in each cell is the identification letter of the parameter that was determined more important and the number is the score given to this parameter. The "subtotal" column is obtained by finding all the cells in the matrix where the parameter identification letter is shown and adding numbers in those cells. For the row "A: Color", for example, there are no cells that contain the letter A, so that parameter receives a subtotal of 0. Row "B: Price", however, receives a subtotal of 6 because there are two cells that contain the letter B and the numbers in those cells add up to 6.

Whenever two parameters are equivalent in terms of importance, the cell will contain the letter designation for both parameters and no numeric score is given.

Numbers in the ranking column are determined by simply equating the highest subtotal with a ranking of 1, the second highest subtotal with 2, and so on.

An Analysis Matrix is now used to rank the alternatives in order of preference. First, alternatives are evaluated as to how well they meet each parameter, typically on a scale of 1 to 4. Let us assume that alternative 1 is cheap and slow, but the right color; while alternative 2 is more expensive and ugly, but faster. For this example, assume subject matter specialists determine that alternative 1 meets the price parameter by a score of 3 on a scale of 1 to 4, meets the speed parameter by a score of 2, and meets the color parameter by a score of 4. Alternative 2 meets the price parameter by a score of 2, the speed parameter by a score of 3, and the color parameter by a score of 1. Here is how the Analysis Matrix would look:

	Price 6	Speed 3	Color 0	Total	Alternative Ranking
Alternative 1	3 / 18	2 / 6	4 / 0	24	1
Alternative 2	2 / 12	3 / 9	1 / 0	21	2

The alternatives are displayed in the left column. Evaluation parameters are displayed, in rank order, on the top row along with their weights as obtained from the Paired Comparison Matrix. Two numbers appear in each matrix cell. The number to the left is the score obtained when comparing the alternative with the evaluation parameter; the number to the right is obtained by multiplying this score times the weighing factor for the parameter. Adding along the row gives a total "grade" for the alternative. The alternative with the highest grade receives the highest ranking and is, therefore, the preferred alternative.

The following section applies this technique to the Rindge Dam/sediment removal alternatives.

APPLICATION

Evaluation parameters for the Rindge Dam/sediment removal alternatives were determined at a February 17, 1994 meeting among representatives of Fish and Game, Parks and Recreation, and Reclamation.

The ten parameters are shown below:

PARAMETER IDENTIFICATION LETTER	PARAMETER
A	Minimize cost
B	Minimize community and fishery impacts
C	Minimize regulatory constraints
D	Minimize impacts to Malibu Lagoon
E	Minimize impacts to Malibu Canyon traffic
F	Maintain historical significance
G	Simplify steelhead fishery restoration process
H	Protect riparian habitat
I	Simplify public awareness process
J	Minimize risks of downstream property damage

After formulating the parameters, the group went through the comparison exercise. As each parameter was compared with the others, the group discussed the relative merits and came to consensus on a comparison score. The results of that effort are shown on the Paired Comparison Matrix presented on Table 3 (Page 23).

The comparison exercise resulted in minimizing impact to Malibu Lagoon as being the most important parameter, followed by minimizing impacts to the residential community and the fishery, protecting riparian habitat, and minimizing the risk of downstream property damage. Other parameters, including cost, were deemed to have much lower importance.

Table 4 (Page 24) shows the Analysis Matrix. When the three alternative methods of removing Rindge Dam and sediment were evaluated against the weighted parameters, removal of the dam and sediment from the canyon was the preferred alternative. Use of an engineered fill in the canyon was a close second, while removal of the sediment by stream erosion was a distant third.

The outcome of the alternative evaluation process obviously depends upon the evaluation parameters selected, the weight given to each parameter, and the determination of how well an alternative meets each parameter. If evaluation parameters are added or subtracted to the list or if changes are made to scores on the matrices, the alternative ranking outcome could change, particularly since only a small difference separates the top two alternatives.

TABLE 3

PAIRED COMPARISON MATRIX

	B	C	D	E	F	G	H	I	J	Subtotal	Ranking
Minimize Cost of Removal A	B3	A/C	D3	E2	A3	G2	H3	I2	J3	3	8
Minimize Impact of Removal B		B3	D2	B3	B3	B3	B1	B3	B/J	19	2
Minimize Regulatory Constraints C			D3	E3	C2	G1	H3	I1	J3	2	9
Minimize Impacts to Malibu Lagoon D				D3	D3	D3	D2	D3	D/J	22	1
Minimize Impacts to Malibu Canyon Traffic E					E3	E/G	H3	E/I	J3	8	5
Maintain Historical Significance F						G3	H3	I3	J3	0	10
Simplify Removal Process G							H3	G2	J3	8	6
Protect Riparian Habitat H								H3	H/J	18	4
Simplify the Process of Public Awareness I									J3	6	7
Minimize the Risk of Downstream Property Damage J										18	3

TABLE 4
ANALYSIS MATRIX

ALTERNATIVES	Minimize Impacts to Malibu Lagoon		Min. Residential Disruptions & Fishery Impacts	Minimize the Risk of Downstream Property Damage	Protect Riparian Habitat	Minimize Impacts to Malibu Canyon Traffic	Simplify Process of Restoring Steelhead Fishery	Simplify the Process of Public Awareness	Minimize Costs	Minimize Regulatory Constraints	Maintain Historical Significance	TOTAL	FINAL RANKING
	22		19	18	18	8	8	6	3	2	0		
1. Removal of sediment by excavation and hauling.	4 / 88		3 / 57	4 / 72	2 / 36	2 / 16	3 / 24	4 / 24	2 / 6	3 / 6	3 / 0	329	1
2. Excavate and conveyor sediment to engineered fill.	4 / 88		3 / 57	3 / 54	2 / 36	4 / 32	3 / 24	3 / 18	3 / 9	2 / 4	3 / 0	322	2
3. Remove portions of dam and displace sediment by stream erosion.	2 / 44		2 / 38	2 / 36	2 / 36	4 / 32	4 / 32	3 / 18	4 / 12	2 / 4	3 / 0	252	3
4. Remove entire dam and displace sediment by stream erosion.	1 / 22		1 / 19	1 / 18	1 / 18	4 / 32	4 / 32	3 / 18	4 / 12	1 / 2	3 / 0	173	5
5. Hydraulically dredge and slurry sediment to disposal site.	1 / 22		1 / 19	4 / 72	2 / 36	3 / 24	1 / 8	3 / 18	2 / 6	2 / 4	3 / 0	209	4

CHAPTER 7

RECOMMENDATIONS AND CONCLUSION

CHAPTER 7: RECOMMENDATIONS AND CONCLUSION

POSSIBILITY FOR ALTERNATIVE COMBINATIONS

During this study, several alternatives for removing the dam and sediment were considered as individual, stand-alone projects. However, opportunities may be optimized by combining several alternatives. For example, sediment material behind the dam that has economic value could be used to provide an economic return (or, at least, minimize cost), while other material could be disposed of in an engineered landfill.

Various alternative combinations should be formulated during more detailed studies. Significant cost savings could be achieved through such combinations and other advantages may exist in formulating an alternative that combines several possibilities considered during this study.

During this study, impacts to the environment were included in the evaluation parameters--specifically the aquatic environment, the terrestrial environment in Malibu Canyon, and the transportation environment on Malibu Canyon Road. Combining several alternatives may provide the opportunity to balance impacts to these environments such that the overall effects are minimized.

Another prime consideration is the "recycling" of the sediment material behind the dam. Instead of placing the material in a landfill (and, in essence, wasting it), it may be used for beneficial purposes. Construction material, beach replenishment, and sanitary landfill covering are several of the possible uses.

Prior to deciding on a final dam and sediment removal plan, additional analyses of alternative combinations should be pursued. This can be done only as more information is obtained on specific uses of the sediment material.

FUTURE WORK REQUIREMENTS

During the study process, it became obvious that development or analysis of some significant items were beyond the scope of this effort. As these items could influence the selection of the final construction alternatives and could make consequential changes in funding requirements, each will need further study during a more detailed planning/design effort.

Location of a sediment disposal site also needs to be specifically identified. During this study, numerous locations for sediment disposal were addressed, but none were evaluated to the extent that one could be identified as preferred over another. More detailed studies are needed to determine the disposal location.

Environmental, social, and economic impacts could also affect the selection of a preferred alternative and the design of that alternative. Thus, these impacts will need to be addressed. Fish and Game will be responsible for pursuing these topics of concern. It is anticipated that should the Reclamation be involved in any further planning or design efforts, its responsibilities will be limited to determination of disposal sites and technical aspects of sediment and dam removal.

CONCLUSION

This study has identified and evaluated several alternatives for removing Rindge Dam and sediment behind the dam. Two alternatives stand out as the most desirable: "Mechanical Removal of Dam and Sediment from Malibu Canyon" and "Engineered Landfill in Malibu Canyon". These alternatives can be implemented within constraints established for the project, but both are relatively expensive. However, opportunities for significant cost savings may be realized through formulation of a combined alternative. Any further investigation of this project should pursue that possibility.

It should also be emphasized that data used as a basis for the analyses performed for this report are preliminary. More detailed engineering and economic analyses and the addition of environmental and social analyses may affect the final selection of a project.

APPENDIX A:
ANALYSIS OF SEDIMENT QUANTITY DEPOSITED UPSTREAM OF RINDGE DAM

APPENDIX A: ANALYSIS OF SEDIMENT QUANTITY DEPOSITED UPSTREAM OF RINDGE DAM

Introduction

This appendix addresses a discrepancy between sediment volume behind Rindge Dam originally estimated by Reclamation and an estimate made by Law/Crandall, a geotechnical consultant under contract with Fish and Game.

First, it must be emphasized that this Reclamation report documents results of an appraisal level study only. Quantities and costs are estimates based on data available to Reclamation at the time the study was done, from the following sources: USGS map dated 1950 (photo-revised 1967), Attachment A; as-built drawings of Rindge Dam dated March 1924 and October 1961, Attachments B and C; and photographs of the area taken by Reclamation personnel in 1993. Funding was not available to perform on-site investigations or surveys.

In estimating costs and time for removing Rindge Dam and sediment deposited behind the dam, the volume of sediment is the most important quantity common to all removal alternatives. Initial Reclamation calculations indicated that the volume of sediment is approximately 1.6 million cubic yards. Subsequently, Law/Crandall, a contractor hired by Fish and Game to provide a geotechnical report of the area, estimated the volume of sediment to be approximately 800,000 cubic yards. This appendix explains Reclamation's process to arrive at its sediment volume of 1.6 million cubic yards and compare that figure with the estimate made by Law/Crandall.

Reclamation Method of Estimating Sediment Deposited Upstream of Dam

(1) Reclamation used a USGS map dated 1950. The area around Rindge Dam was enlarged by 400 percent on a photocopy machine.

(2) The elevation contours and other features (highways and streams) from the enlarged portion of the map of the area around Rindge Dam were digitized into an Autocad 12 computer drawing file.

(3) The 1950 USGS map did not show the contours of the original Malibu Creek streambed upstream of the dam because a substantial quantity of sediment had already been deposited by that time. Nor did the contours of the area reflect the current elevation of the top of sediment since considerable sediment has been deposited since 1950.

(a) To establish approximate contours for the natural streambed, Reclamation assumed a constant slope stream gradient from a point immediately downstream of the dam to a point immediately upstream of the limits of the deposited sediment.

(b) An average elevation of the top of sediment was approximated as follows:

Elevations of the top of dam and spillway were taken from as-built engineering drawings dated March 1924 and October 1961. Elevation of top of dam: 335 Spillway Elevation: 327

Photographs show the sediment upstream of the dam. At the spillway, the top of sediment elevation is 327. The top of sediment elevation rises northward across the valley to the far end of the dam. Due to the manner in which sediment tends to be deposited in valleys subject to periodic flooding, it is reasonable to expect (and is evident in the photographs) that the top of sediment elevation will be higher outside the main channel of Malibu Creek.

The photographs show that the top of sediment elevation remains below the top of the dam, but is, on average, higher than the spillway. These observations were confirmed during a visit to the site by Reclamation personnel in May 1994.

Based on the above information, Reclamation considered it reasonable to assume an average elevation of 330 for the top of sediment.

Reclamation applied the above approximations to the Autocad drawing created in (2) to produce a topographical map of the area reflecting conditions current as of March 1994. (See Drawing No. X-LC-219, Attachment F.)

(4) Reclamation used the Autocad drawing and a Reclamation computer program to calculate the volume of sediment deposited upstream of Rindge dam.

(a) The program used the Autocad drawing data to generate cross sections of the valley at 200 foot intervals and to calculate the area of the sediment in each cross section (see Drawing Nos. X-LC-219 and X-LC-220, Attachments F and G). It should be noted that the depth of sediment reflected in these cross sections reasonably agrees with the depth of sediment reported by Law/Crandall.

(b) The program then used the average end-area formula to calculate the volume of sediment based on the area of the cross sections. The average end-area method is commonly used to calculate earthwork quantities. This generated the 1,624,500 cubic yard figure used as the original Reclamation estimate for the volume of sediment.

(5) The program used in (4) was similarly applied to calculate the volume of sediment in each of six lifts shown on Drawing No. X-LC-217 (Page 7).

Quick Check of Reclamation Quantity Estimate

In the interest of verifying the general magnitude of the 1.6 million cubic yard figure as the volume of sediment deposited upstream of the dam, Reclamation noted that construction and design reports for Rindge Dam indicated that the dam was expected to impound approximately 574 acre-feet of water.

Conversion of 574 acre-feet yields a volume of 926,053 cubic yards. This would be the volume of water impounded behind the spillway with a water surface elevation 327. As noted in (3)(b) above, Reclamation estimated the elevation of the top of sediment to be 330. This indicates that one should expect a volume of sediment somewhat more than 926,053 cubic yards. It should be noted that even a variation of a few feet of sediment around elevation 330 can result in a difference of 100,000 cubic yards.

The 926,053 cubic yard figure is substantially less than the 1.6 million cubic yards Reclamation calculated and more closely agrees with the Law/Crandall estimate.

The Law/Crandall Quantity Estimate

Site investigations conducted by Law/Crandall were for the purpose of producing a geotechnical report. The contractor took four borings to analyze and provide a description of the sediment layers deposited upstream of the dam.

The depth of sediment at the four borings reasonably agrees with Reclamation cross sections developed at these points. (See Drawing No. X-LC-219, Attachment F).

The contractor provided an estimate of the volume of sediment by: 1) using the depth of the four borings; and 2) calculating the areal extent of the deposited sediment by using a planimeter.

There is no indication that a site survey was employed to establish either the elevation of the top of sediment or the extent of the deposited sediment.

Quick Check of Law/Crandall Quantity Estimate

Checking Law/Crandall's quantity estimate by applying the average-end-area method of estimating sediment deposited behind the dam (Attachments D and E were used to determine the sediment length and cross-sectional areas, respectively), yielded a calculated quantity of 1.16 million cubic yards. This value in itself varies from the Law/Crandall estimate of 0.8 million cubic yards. The values and calculations used to arrive at the 1.16 million cubic yards are listed in Attachment F. This indicates that the quantity of sediment located behind the dam varies depending upon the method of calculation used. The estimated areas for Law/Crandall cross-sections are shown on Drawing No. X-LC-219 (Attachment F), and Drawing No. X-LC-220 (Attachment G), contains the calculated sediment volume.

Source of the Discrepancy

The discrepancy between the volume of sediment estimated by Law/Crandall and Reclamation appears to have resulted from a combination of differences, including calculation methodology, length of sediment deposited upstream of the dam, top elevation of sediment, and cross sectional areas. The Law/Crandall drawing shows an elevation of 285 for top of sediment, while Reclamation estimated the top of sediment elevation to be 330; Reclamation used the average-end-area method, while Law/Crandall calculated soil layer volumes; Reclamation used 4400 feet as the distance sediment is deposited upstream of the dam, while Law/Crandall used 2870 feet; Reclamation's cross sectional areas are larger than Law/Crandall's areas at similar locations.

The Malibu Creek Sediment Transport Analysis

Mr. E. Woody Trihey, P.E., published the Malibu Creek Sediment Transport Analysis report, March, 1989. In the report, Mr. Trihey estimated the volume of sediment behind Rindge Dam to be 1.169 million cubic yards. The method Mr. Trihey used to calculate the sediment quantity was by the average-end-area method.

Initial Decision to Use 1.6 Million Cubic Yards Figure

Given the information available at the time Reclamation developed the estimate (prior to receiving the Law/Crandall report), it appeared that the volume of the sediment deposited upstream of the dam was between 1.0 and 1.6 million cubic yards.

Reclamation used the higher figure as it was derived from data taken from a USGS map (modified to approximate existing conditions) and from as-built engineering drawings. The possibility of seriously underestimating the quantity of the item that would most impact cost and time estimates was also avoided.

Reclamation acknowledges that there are weaknesses with the methodology described above. In particular:

(1) The USGS topographic map used to create the Autocad drawing provided elevation contours at only 25 foot intervals, requiring considerable interpolation of intermediate elevations. As discussed elsewhere in this report, differences in elevation of only a few feet will drastically effect the quantity of sediment estimate.

(2) Photocopy enlargement of the USGS map undoubtedly produced some distortion of the elevation contours.

(3) The actual profile of the natural streambed may differ considerably from the one Reclamation assumed based on a constant gradient.

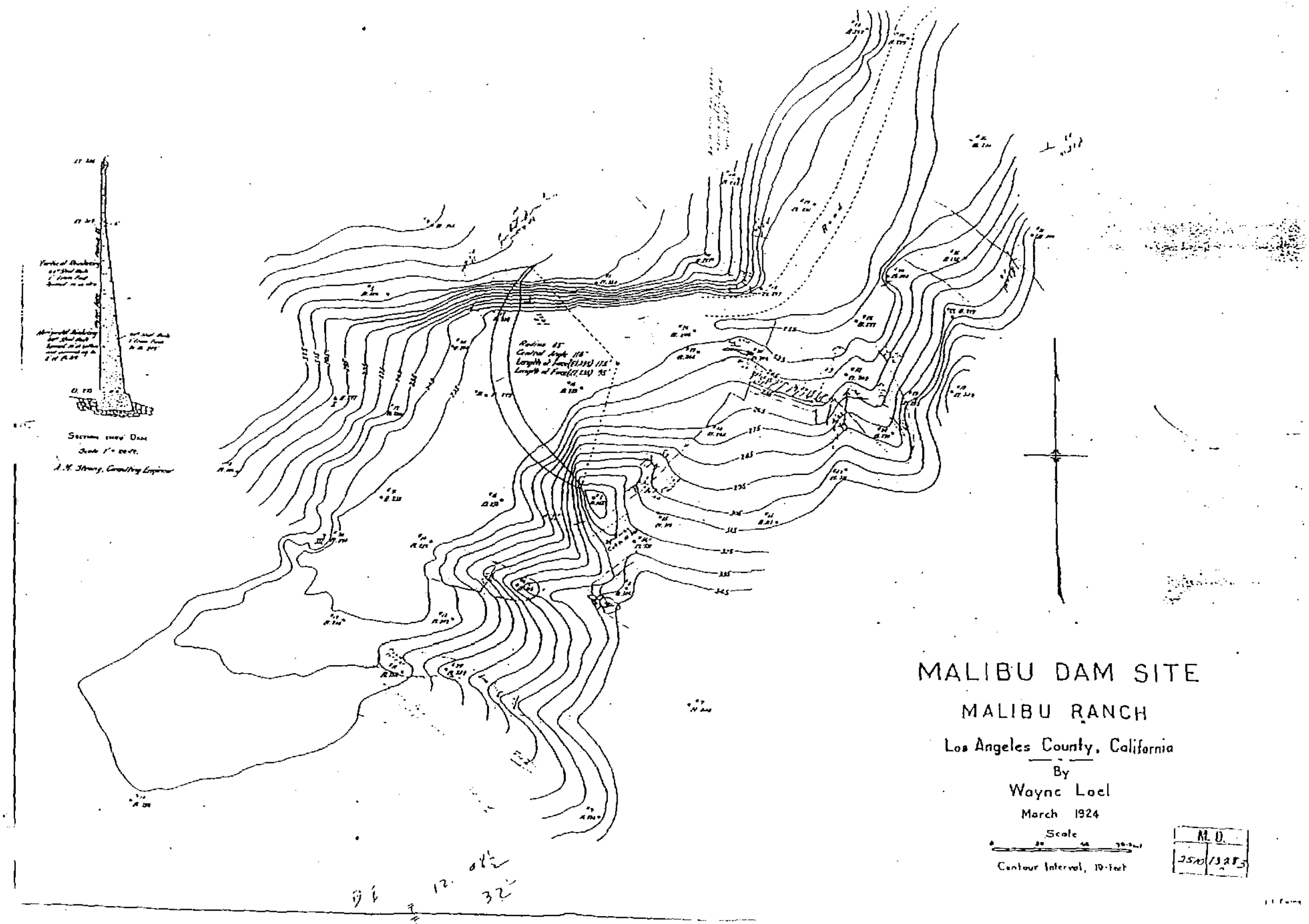
(4) The actual average top of sediment elevation and extent of sedimentation may differ considerably from what Reclamation assumed based on photographs and as-built engineering drawings.

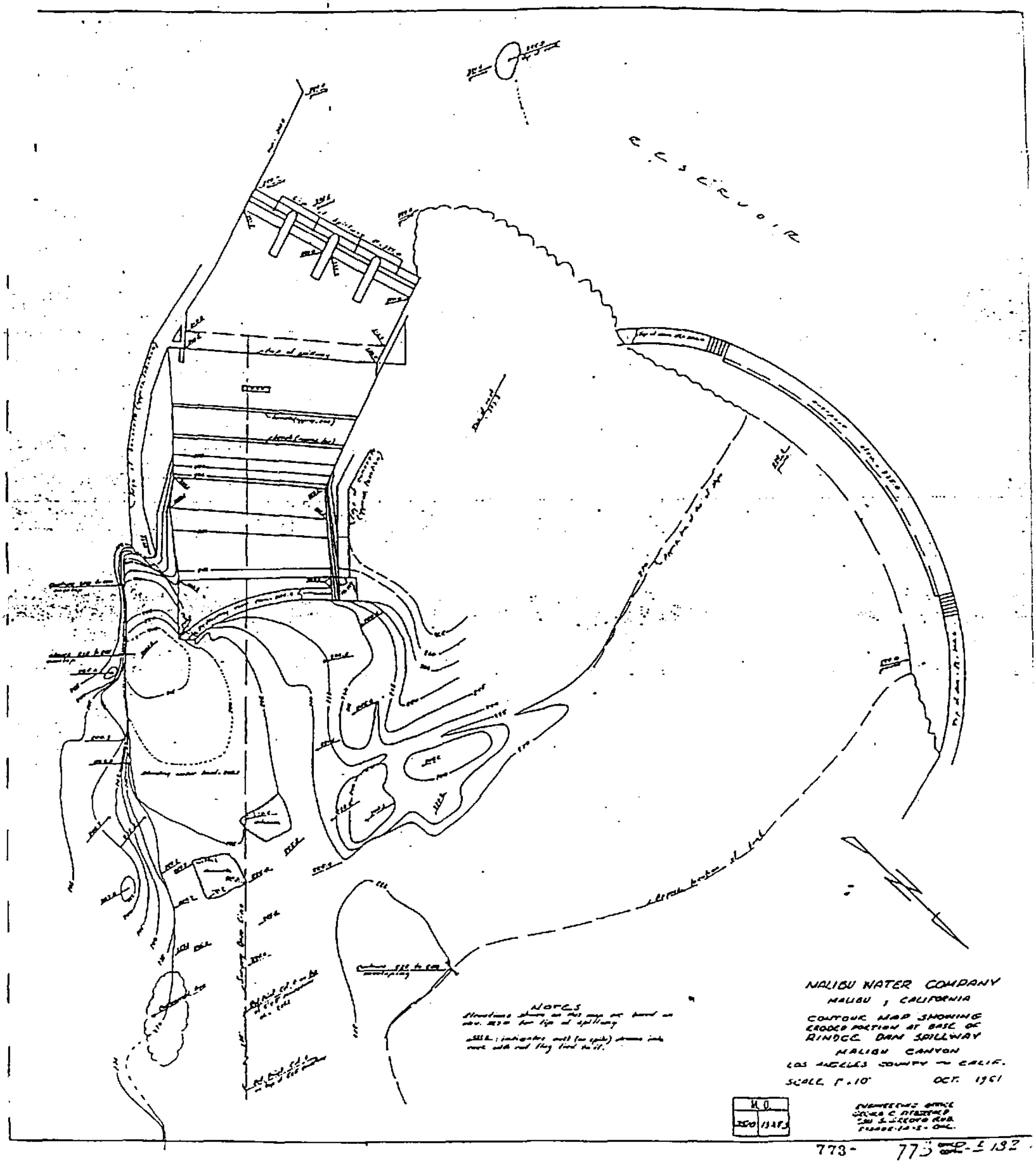
Conclusion

Reclamation believes the quantities and costs contained in this report should be used only for relative comparisons of the options evaluated herein. Considering the uncertainty inherent in all the quantities involved (not just the volume of sediment), it would be misleading to represent the cost estimates in this report as anything more than preliminary.

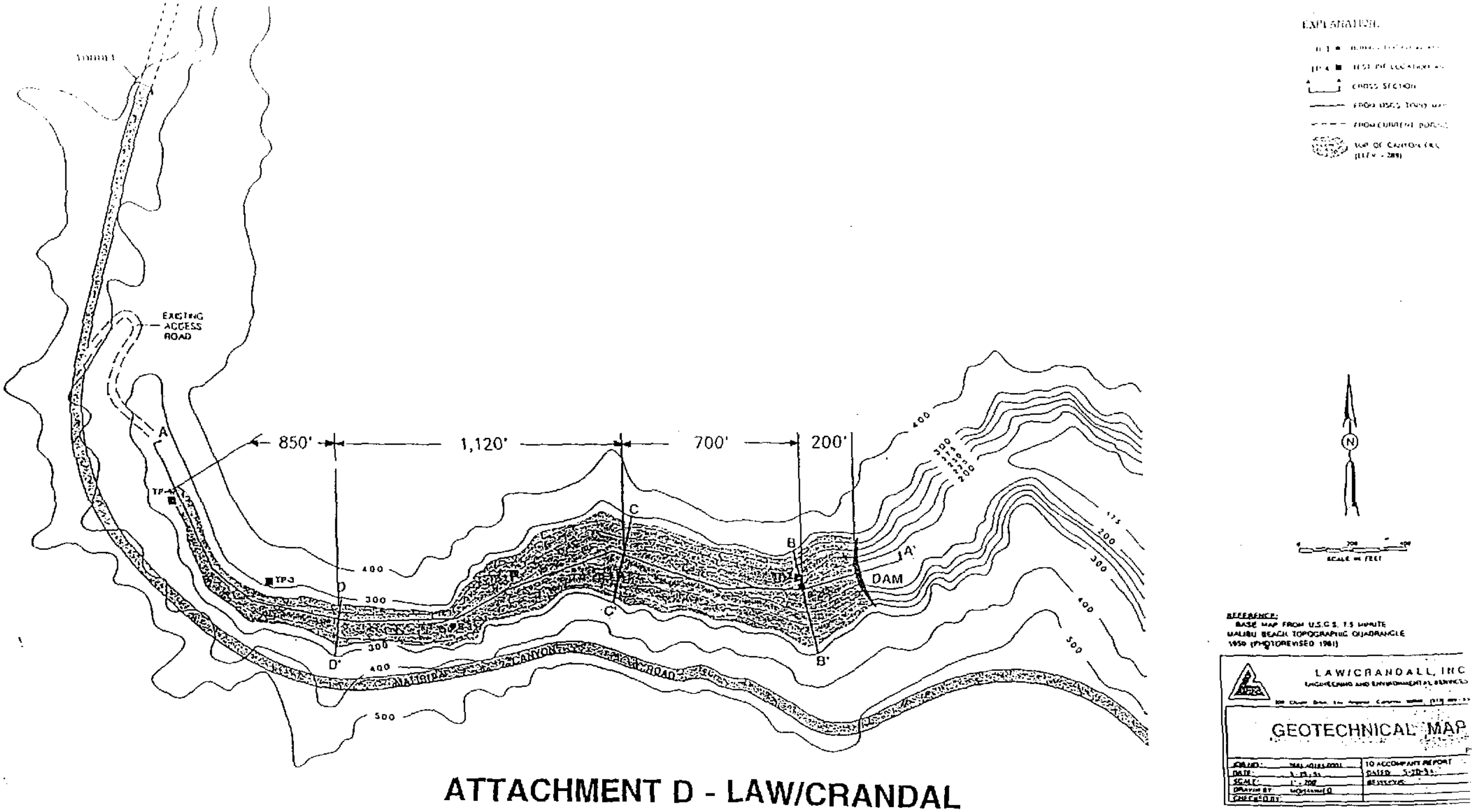
At the request of Fish and Game, Reclamation used the quantity of deposited sediment value from the Law/Crandall report as the basis for the estimates of cost and construction time in this report. Fish and Game is attributed as the source of the value, as Reclamation has no technical basis for confirming or disputing the figure.

ATTACHMENT A - USGS MAP

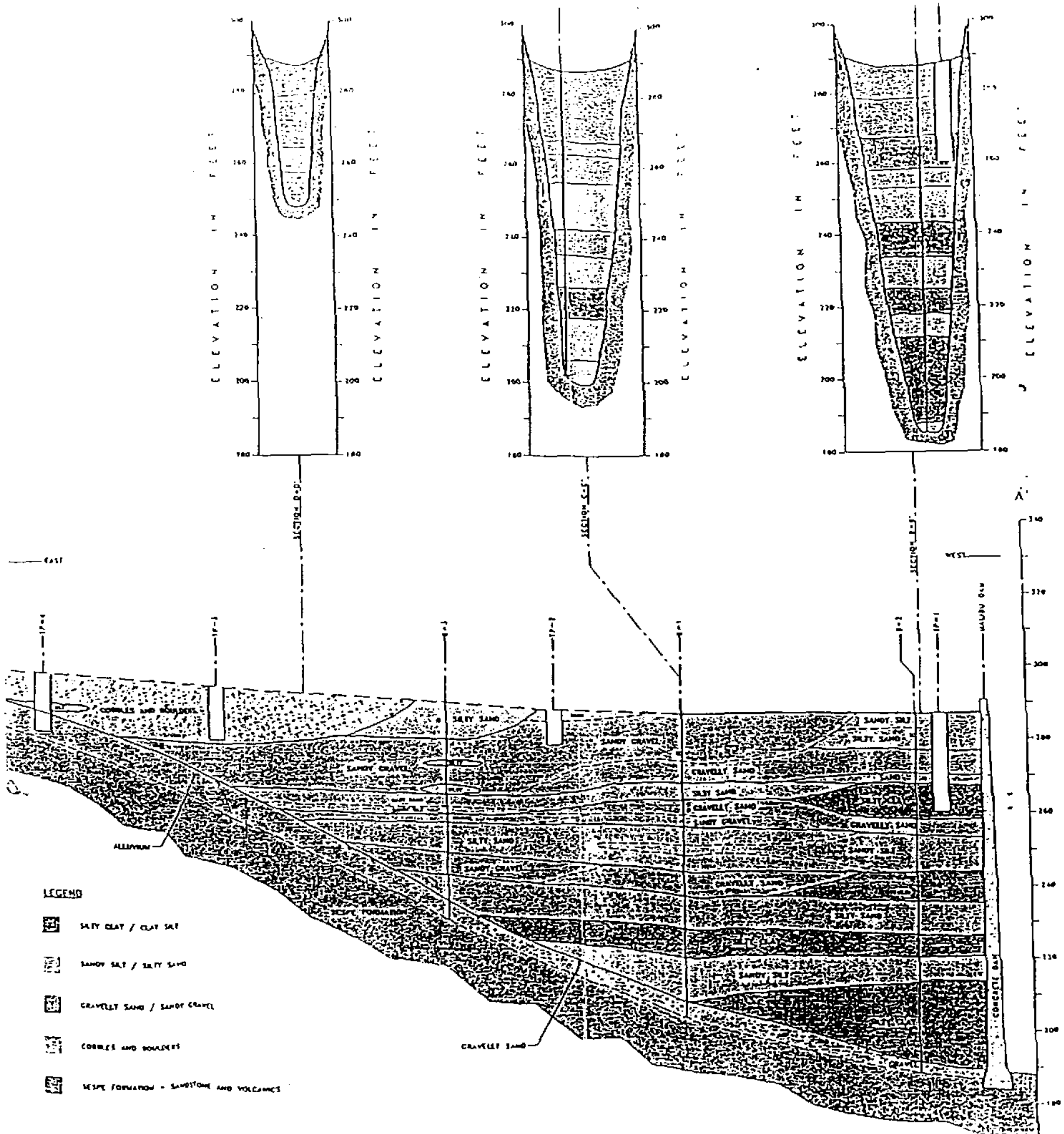

MALIBU DAM SITE
MALIBU RANCH
Los Angeles County, California
By
Wayne Loel
March 1924
Scale
Contour Interval, 10 Feet
M. D.



ATTACHMENT C - RINDGE DAM 1961



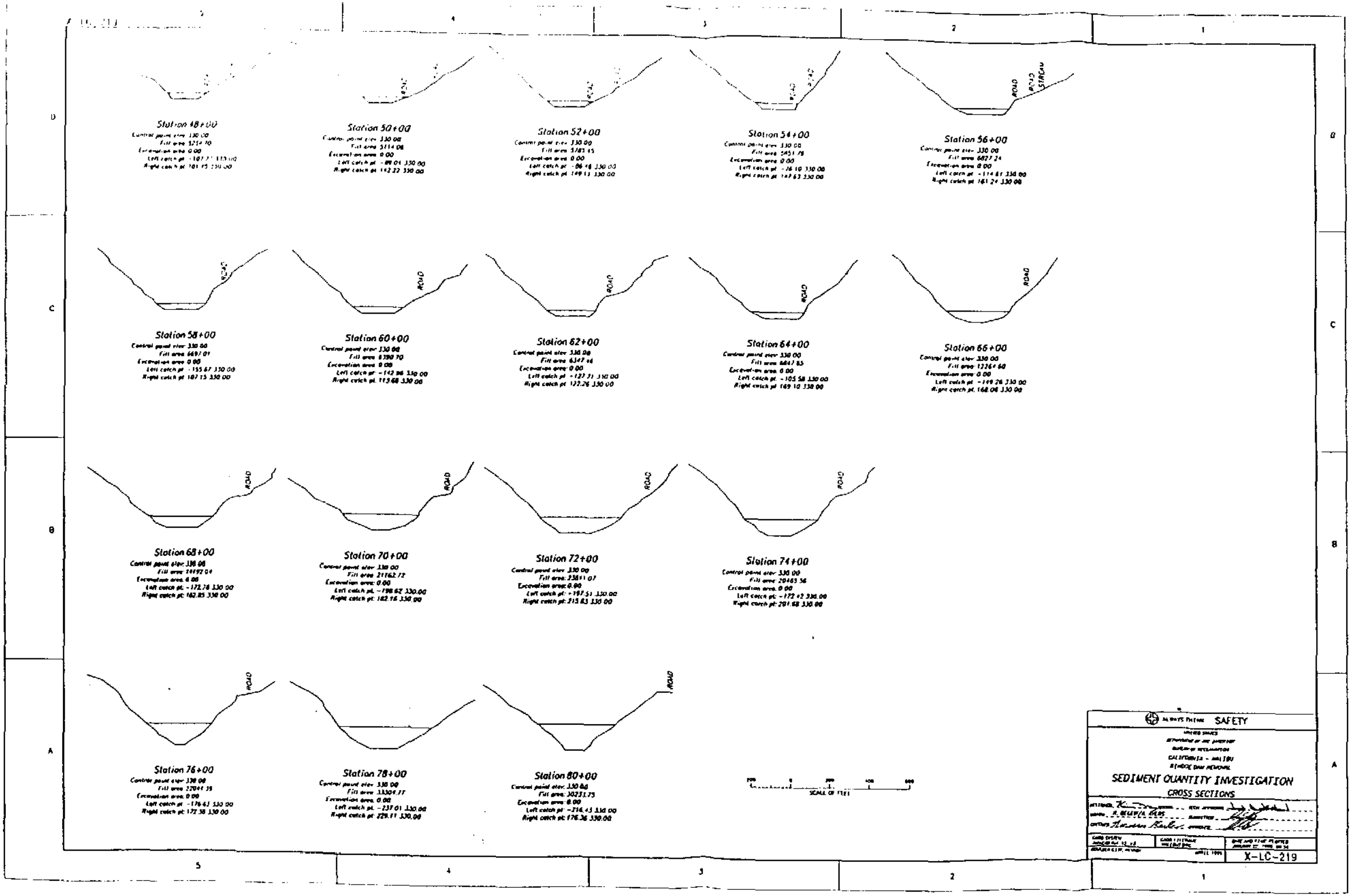
ATTACHMENT D - LAW/CRANDAL PLAN VIEW DRAWING



GEOLOGIC SECTIONS

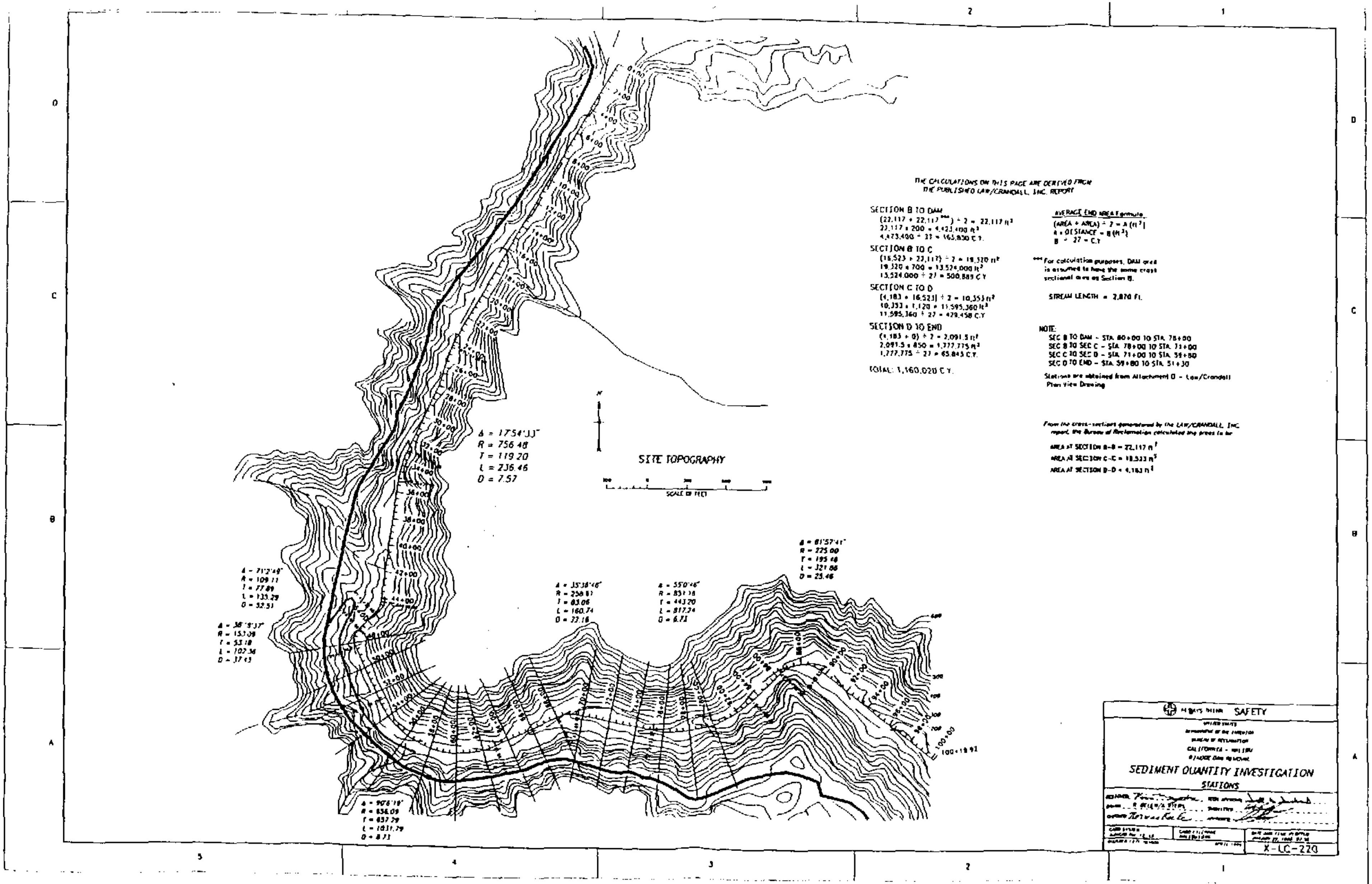
SCALE: HORIZONTAL 1" = 100'
VERTICAL 1" = 20'

ATTACHMENT E - LAW/CRANDAL



ATTACHMENT F - DRAWING X-LC-219

ATTACHMENT G - DRAWING X-LC-220



APPENDIX B: REFERENCES

APPENDIX B: REFERENCES

Franklin, Robert F. and Soyka S. Dobush, Malibu Creek Steelhead Habitat Assessment Report, ENTRIX, Inc., 1989.

Law/Crandall, Inc., Report of Geotechnical and Environmental Study, Malibu Creek Steelhead Restoration Project, Malibu Area, Los Angeles County, California, May 23, 1993.

Trihey, E. Woody, P.E., Malibu Creek Sediment Transport Analysis, March 1989.

Attachment 8:
Elwha River Dam Removal
Draft EIS
Olympic National Park
April '96

Elwha River

Ecosystem

Restoration

Implementation

Summary
Draft Environmental
Impact Statement
April 1996

Olympic National Park
Washington

Draft Environmental Impact Statement

Elwha River Ecosystem Restoration Implementation

Purpose and Need: The Elwha River ecosystem and native anadromous fisheries are severely degraded as a result of two hydroelectric dams (projects) and their reservoirs built in the early 1900s. Congress has mandated the full restoration of this ecosystem and its native anadromous fisheries through the Elwha River Ecosystem and Fisheries Restoration Act (Public Law 102-495). The Department of the Interior has found there is a need to return this river and the ecosystem to its natural, self-regulating state, and proposes to implement the Congressional mandate by removing both dams in a safe, environmentally sound and cost effective manner and implementing fisheries and ecosystem restoration planning. No other alternative would fully restore the ecosystem or its native anadromous fisheries.

Proposed Action – River Erosion Alternative: The U.S. Department of the Interior proposes to fully restore the Elwha River ecosystem and native anadromous fisheries through the removal of Elwha Dam and Glines Canyon Dam and implementing fish restoration and revegetation. Dam removal would occur over an 18-month to 2-year period. Elwha Dam would be removed by blasting, and Glines Canyon Dam by a combination of blasting and diamond-wire saw cutting. Lake Aldwell would be drained by a diversion channel, and Lake Mills by notching down Glines Canyon Dam. Stored sediment would be eroded naturally by the Elwha River. The project area is located in Clallam County, on the Olympic Peninsula, in Washington State.

Lead agency: National Park Service

Cooperating agencies: U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, U.S. Bureau of Indian Affairs, U.S. Army Corps of Engineers, and the Lower Elwha Klallam Tribe

Type of statement: This is a draft environmental impact statement which is procedurally connected (tiered) to the Department of the Interior Elwha River Ecosystem Restoration Final Environmental Impact Statement (June 1995). This statement examines alternatives for implementing the policy choice to remove both Elwha and Glines Canyon Dam based on Interior's Elwha River Ecosystem Restoration statement.

Abstract: In addition to the proposed action, two other alternatives are examined. They are: the Dredge and Slurry alternative (removing fine-grained sediment prior to dam removal by using suction dredges, and sending the slurry to the Strait of Juan de Fuca in a pipeline), and No Action (dams are retained as is, without fish passage measures). The proposed action is also the Department of the Interior's preferred alternative. Short-term negative impacts from removing both dams could result from the release of sediment now trapped in the reservoirs. The finer grained particles could temporarily but significantly impact fish or other aquatic organisms. Impacts on water quality, river morphology, flooding, native anadromous and resident (e.g. trout and char) fisheries, living marine resources, wildlife, threatened and endangered species, vegetation, cultural resources, land use, recreation, aesthetics, and socioeconomics are examined in this environmental impact statement. Both of the other alternatives would also have significant impacts on resources examined in this document.

Public Comment Period: Written comments will be taken for a period of 60 days on the draft environmental impact statement. They should be sent to Sarah Bransom, National Park Service, Denver Service Center, Resource Planning, DSC-RP, 12795 West Alameda Parkway, P.O. Box 25287, Denver, Colorado 80225-0287, phone (303)969-2210. Public meetings to take oral and/or written comments will be scheduled during this time. Questions on the project should be addressed to Dr. Brian Winter, Elwha Project Leader, at Olympic National Park in Port Angeles, (360) 452-0302.

Summary

Introduction

This document is a draft environmental impact statement (DEIS), prepared to analyze environmental impacts of alternative ways to remove two hydroelectric projects on the Elwha River. This DEIS is the second of two, which in combination study how to fully restore the river's dam-altered ecosystem and native anadromous fisheries in a safe, environmentally sound and cost-effective manner. The first, "programmatic" EIS (Elwha River Ecosystem Restoration Final Environmental Impact Statement) was finalized in June, 1995. The programmatic EIS is procedurally connected (tiered) to this document, the *Implementation EIS*.

Professionals in a variety of technical fields from a group of federal agencies and the Lower Elwha Klallam Tribe, as well as consultants and the public helped define project objectives and the range of reasonable alternatives. They also analyzed the impacts of those alternatives to important environmental resources. The National Park Service is the lead agency in the production of this analysis and documentation, and the US Bureau of Reclamation, US Fish and Wildlife Service, US Bureau of Indian Affairs, US Army Corps of Engineers and Lower Elwha Klallam Tribe are cooperating agencies. This team of agency preparers and contributors is referred to throughout this document as the EIS Team.

The action proposed... in this environmental impact statement is the full restoration of the Elwha River ecosystem and native anadromous fisheries...

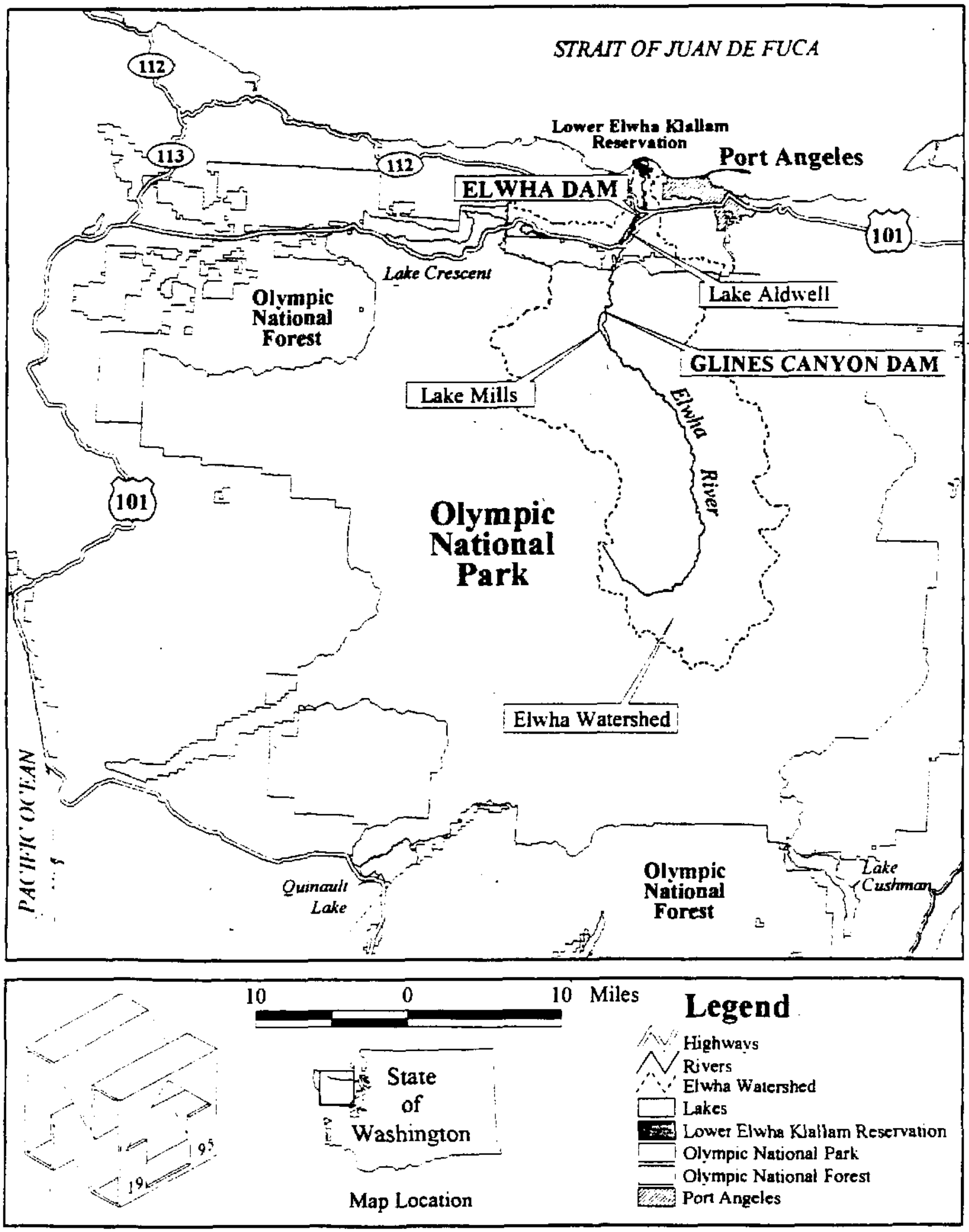
Purpose and Need

The action proposed and analyzed in this environmental impact statement is the full restoration of the Elwha River ecosystem and native anadromous fisheries through the removal of two hydroelectric dams and implementation of fisheries restoration and revegetation. The dams were installed without fish passage facilities on the Elwha River, on the Olympic Peninsula in Washington State (figure 1). Elwha Dam was built first, 4.9 miles from the mouth of the river. Construction spanned the years 1910–1914. Glines Canyon Dam was completed 8.5 miles further upstream in 1927. Both impound reservoirs: the Elwha Dam forms the Lake Aldwell reservoir, and Glines Canyon Dam forms the Lake Mills reservoir.

Before the dams were built, the Elwha River produced an estimated 380,000 migrating salmon and trout. The construction of Elwha Dam eliminated 93% of Elwha River habitat for these anadromous fish, and began what became a precipitous decline in the native populations of all 10 runs of Elwha salmon and sea-going trout.

Salmon populations in the Elwha River are not the only ones declining, nor are dams the only reason for their decline. Salmonid numbers in many rivers

Figure 1. *Location Map*
Olympic National Park
United States Department of the Interior - National Park Service
DSC - December 1995 - 149 - 20055B



of the Pacific Northwest are falling for a variety of reasons. Some species are overfished, some are affected on a large scale by fluctuations in the marine environment, and some are affected by conditions in their freshwater habitat. Silt from logging, dredging for gold and from the building and use of roads covers and smothers eggs. Water diversions for industrial, municipal or commercial use, and the addition of pollutants such as pesticides all increase fish disease and mortality.

However, dams, even with fish measures installed, are a primary cause of fish mortality. It is estimated the series of dams on the Columbia-Snake river system kill 85 to 95% of migrating smolts on their way to sea, and between 34 and 57% of adults returning to spawn (Sims 1994). This is despite an estimated $1.5 billion spent over the last 13 years to implement fish passage measures on the Columbia and Snake rivers (Satchell 1994). Degraded freshwater habitat is often expensive and difficult to restore because of developments like dams, roads, agriculture, and water withdrawals for municipal and industrial use. In contrast, the Elwha River remains in pristine condition along most of its length. The single action of removing both dams would restore to pre-dam, high quality condition the vast majority of habitat formerly available to Elwha anadromous fish.

Several specific problems for native anadromous fish and the Elwha River ecosystem are a direct result of the dams. Neither dam has passage measures for fish, and so they obstruct upstream fish migration beyond the first 4.9 miles of the river. The natural transport of coarse sediment downstream has also been halted by the dams and its resulting absence has rendered the river downstream of the dams largely unusable by fish. Salmon and steelhead once filled 70 miles of mainstem and tributary habitat in the Elwha. Their carcasses fed more than 22 species of wildlife and supplied the entire aquatic ecosystem with organic material, phosphorus and nitrogen. Now, populations of primarily hatchery fish return to only the 4.9 miles of river below the Elwha Dam to spawn in crowded, unnatural and poor quality conditions. Both the terrestrial and aquatic ecosystems are less productive and varied as a result.

Chinook salmon in the lower Elwha River. (Natalie Fobes photo)

Humans have occupied the Elwha valley for thousands of years, and have integrated the river and its salmon into much of their daily lives. When the dams separated the fish from their spawning grounds and populations rapidly declined, the Elwha Klallam people were affected culturally, spiritually and economically. Many tribal socioeconomic problems which persist today have had their roots in this decline. The dams are also inconsistent with the federal trust responsibility and treaty rights guaranteed to the Elwha Klallam and three other Indian tribes in the 1855 Treaty of Point No Point and the Treaty with the Makah.

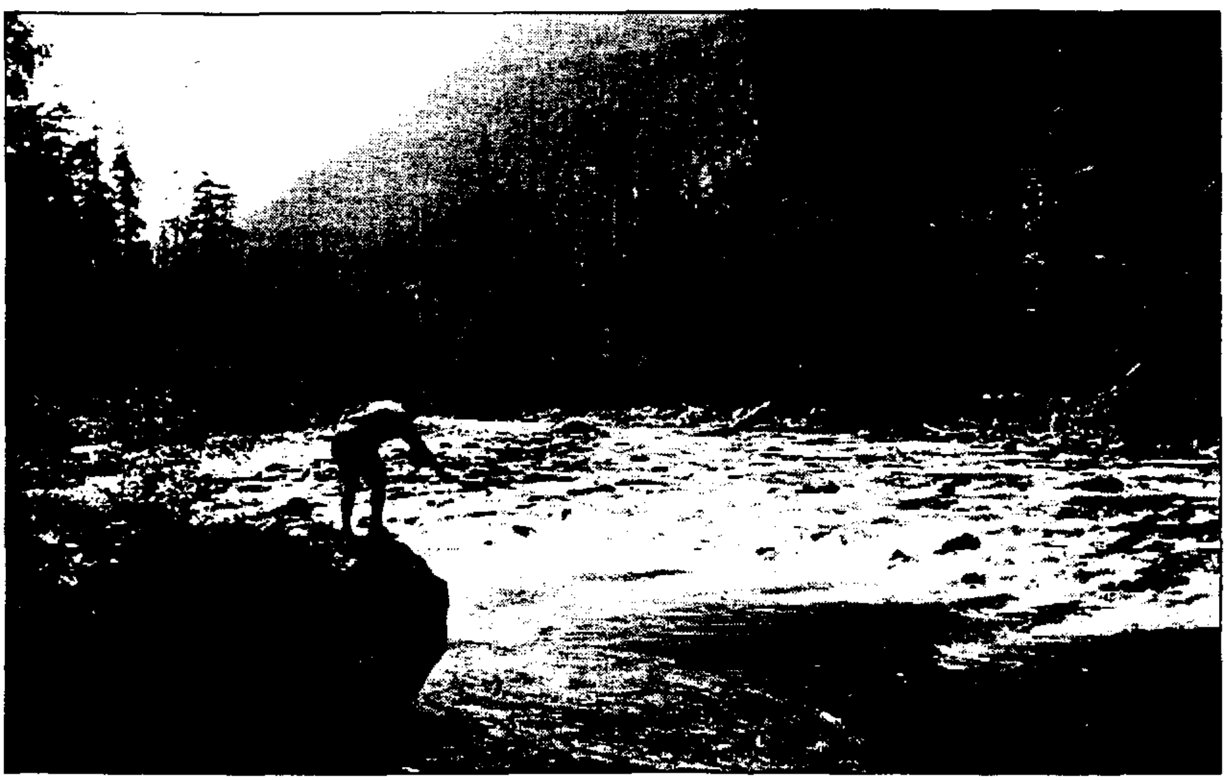
Because the dams and reservoirs on the Elwha River have caused and continue to cause major, adverse impacts to the river's native anadromous fish populations, wildlife, aquatic ecology and cultural resources, the Department of the Interior determined in its programmatic environmental impact statement they would be removed to fully restore the ecosystem and native anadromous fisheries. This EIS examines alternative methods of removing them in a safe, environmentally sound and cost-effective manner and proposes a plan to restore the river's native anadromous fisheries and ecosystem.

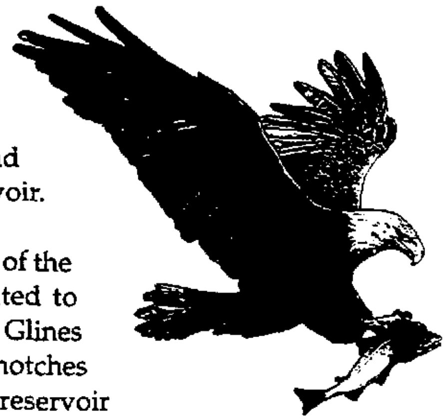
Alternatives

The proposed action (the River Erosion alternative) is to initiate river restoration by removing both dams over a two-year period. Lake Mills would initially be drawn down with Glines Canyon Dam in place to provide flood control water storage until a diversion channel to drain Lake Aldwell is complete. Elwha Dam would be removed by controlled blasting, and Glines Canyon Dam would be removed by a combination of controlled blasting and diamond wire saw cutting of concrete blocks. Sediment would be eroded naturally by the river.

The proposed action would involve lowering Lake Aldwell enough to build a temporary cofferdam and excavate a diversion channel through the north spillway. The reservoir would be lowered through the channel enough to remove fill material, which now serves to control seepage through the dam

Fishing the Elwha in the 1920s. (Asahel Curtis photo, Washington State Historical Society)





foundation. Elwha Dam would then be blasted in sections, and rubble trucked to one or more of nine disposal sites under consideration within a 32-mile radius. Some project features outside the river channel may be buried under backfill material. During the low flow period of the second year, the river channel and dam would be lowered in increments to completely drain the reservoir.

Removal of Glines Canyon Dam would begin following completion of the diversion channel at Elwha Dam, as Lake Mills would be operated to maximize flood storage and minimize work stoppages at Elwha Dam. Glines Canyon Dam would be notched by saw cutting and blasting. The notches would be sized and their removal timed to allow about 7.5 feet of reservoir drawdown every two weeks. Concrete rubble and other waste would be hauled to the disposal sites described above.

The majority of sediment accumulation lies behind Glines Canyon Dam. A portion of this sediment would be eroded naturally by the Elwha River. The reservoir and river channel would be extensively monitored. The sediment release rate from the reservoirs would be controlled by controlling the rate of dam removal.

A second sediment management alternative, the Dredge and Slurry alternative, was also considered and is fully analyzed in this *Implementation EIS*. This alternative involves the use of suction dredges mounted on barges in each reservoir. Fine-grained sediment composed of silt and clay would be slurried with water and sent through a pipeline to the Strait of Juan de Fuca. From Lake Mills to Lake Aldwell, the pipeline would follow roads and the river channel to Lake Aldwell. It would be fixed in place in the river until it reached Elwha Dam where it would follow one of two routes to the strait: the river or county roads.

The Dredge and Slurry alternative and the proposed action (the River Erosion alternative) are referred to as the action alternatives in this EIS. A No Action alternative, or the continuation of conditions as they are now with the dams in place, was also analyzed.

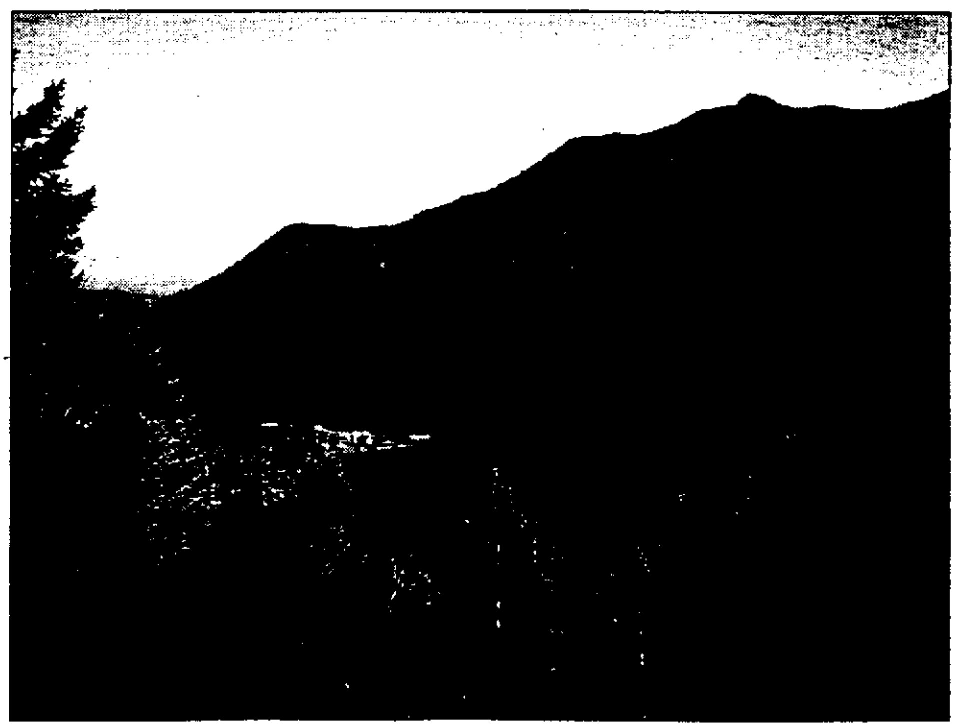
The EIS Team examined many different options for removing the dams and managing the sediment behind them. The reasoning behind eliminating several dam removal and sediment management alternatives is described in the Alternatives chapter, under the section titled "Alternatives Considered But Rejected."

The EIS team also analyzed alternatives for fisheries restoration, revegetation, water quality, flood protection and land management. A summary of actions required or considered to restore, protect, or manage these resources follows.

A variety of measures would be used to help restore the Elwha's salmon and anadromous trout and char. Some of these measures include the use of hatcheries to develop and maintain broodstock, outplanting eggs, fry and smolts by tank truck, helicopters and other means, the use of acclimation ponds in the river, and harvest management (i.e. fishing restrictions). Because the Lower Elwha Tribal Fish Hatchery is needed to accommodate the restoration effort, as well as to protect broodstock during dam removal, it would be fitted with a larger capacity infiltration gallery and new wells located near the river.

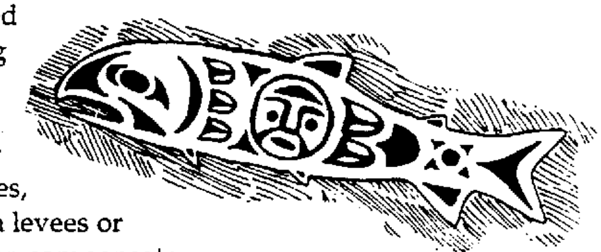
Ecosystem restoration measures would include revegetation of land aquired by Olympic National Park at Glines Canyon damsite and the drained Lake Mills reservoir. Revegetation of the lake beds would involve some natural recolonization and a moderately intensive program of planting native species. Planting seeds, cuttings and trees of different ages would help create a more natural, structurally diverse forest ecosystem in a shorter period of time, and keep exotic vegetation from invading. This, in turn, would create wildlife habitat and habitat usable by species of special concern. The return of salmon and steelhead throughout the river would also provide a fundamental link in restoring the Elwha River aquatic and terrestrial ecosystems.

The Elwha Restoration Act (PL 102-495) requires that industrial and municipal water users experience no adverse impacts from dam removal. This group of users includes the City of Port Angeles municipal and industrial customers served from the Elwha River and the Dry Creek Water Association. The major impact to these users would be to water quality during sediment erosion. Industrial users of Elwha water would be protected by filtering water through the riverbed and collecting it in an infiltration gallery or perforated pipe buried beneath the riverbed. During dam removal, this would be supplemented with open channel pre-treatment with an approved flocculent and a temporary settling basin. The City of Port Angeles municipal supply is already



Lake Mills, Observation Point. (Maggi Johnson photo) experiencing supply problems as the river is meandering away from its current Ranney collector. A second Ranney collector on the opposite side of the river would ensure a constant supply. Treatment for iron and manganese may also be required; if so, a filter would be installed. Dry Creek Water Association could either connect to the city of Port Angeles' Ranney system or to a separate treatment facility built to chlorinate and filter its supply. These measures would protect against adverse project impacts, as well as provide additional longer term benefits to local water users.

Additional mitigation not specifically required by the Elwha Restoration Act, but analyzed by this DEIS and recommended for adoption, would protect individual well users, the Elwha Place Homeowners' Association and Lower Elwha Klallam Tribal residents from adverse impacts of dam removal to water quality or sewage treatment capacity. In addition, increases in flooding from the return to pre-dam elevations of the riverbed and water level may require elevating or otherwise protecting wellheads.



Increases in surface water elevation in some places on the river may also result in increased flooding of homes, cultural resources, or other structures in the floodplain. Building flood protection levees or dikes, or using flood insurance or other means to protect or compensate homeowners are mitigation measures considered.

Minimizing impacts to cultural resources is required by the National Historic Preservation Act. These actions are considered an integral part of both action alternatives, and include surveys, inventorying important historic properties and intensive monitoring during and following dam removal to ensure timely action to prevent or mitigate impacts.

Both action alternatives would include the acquisition of land by the federal government. Lands within Olympic National Park (those now occupied by Glines Canyon Dam facilities and Lake Mills) would be used either for wilderness recreation, interpretive opportunities, or both. Some features of the project would be left in place to help the park explain the history of the dams and their removal to visitors. Lands acquired outside park boundaries (Elwha Dam and Lake Aldwell) would be managed by either the park, the state of Washington, US Fish and Wildlife Service, and/or the Lower Elwha Klallam Tribe. Any of the four land managers would be required by the Elwha Restoration Act to leave lands within the floodplain in a natural condition to accommodate fish restoration.

Costs for each alternative are summarized in table 1 below.

A No Action alternative was also analyzed to provide a comparison for the two action alternatives. Under the No Action alternative, no costs associated with construction would be incurred unless the dams require Federal Energy Regulatory Commission licensing, in which case those costs as identified in the programmatic EIS (DOI et al.1995) to install fish passage measures and

Table 1. *Summary of Costs for Each Action Alternative (thousands of dollars)*

ACTION	RIVER EROSION	DREDGE AND SLURRY
Project/land acquisition	29,800[a]	29,800[a]
Dam removal	33,567	32,951
Road rehabilitation	528	528
Sediment management[b]		22,496
Water quality mitigation	29,770	23,987
Revegetation/wildlife	3,205	3,205
Flooding mitigation	3,998	3,998
Hazardous waste disposal	587	587
Fish restoration[c]	7,380	7,380
Cultural resources mitigation	665	665
Monitoring/modeling	2,144	1,844
Total	111,115	127,441

[a] Includes other lands and rights costs.
[b] Includes cost of slurry pipeline and dredging, all other sediment management costs for both included in monitoring/modeling.
[c] Includes hatchery expansion, operation and maintenance.

other upgrades would apply. Some protection from flooding and water quality treatment is in place now. These measures include large levees on both the east and west side of the river near the mouth, filters to treat water used by the Daishowa and Rayonier mills and underground collection and chlorination of municipal water used by the city of Port Angeles.

Summary of Impacts

Fluvial Processes and Sediment Transport

The natural transport of sediment has been blocked by the dams. As a result, about 8.5 million cubic yards of larger-grained or coarse sediment (sand and larger) and 9.2 million cubic yards of fine-grained (silt and clay-sized) sediment has accumulated in the reservoirs.

Under the proposed action (the River Erosion alternative), between 4.8 and 5.6 million cubic yards of fine-grained sediment (silts and clays) and between 1.2 and 2.6 million cubic yards of coarse-grained sediment (sand-sized and larger), or less than half of the sediment now stored in the reservoir lake beds and deltas, would be naturally eroded by the Elwha River. Successive filling and draining of Lake Mills during dam removal would help move the materials toward the dam face so they could be eroded downstream.

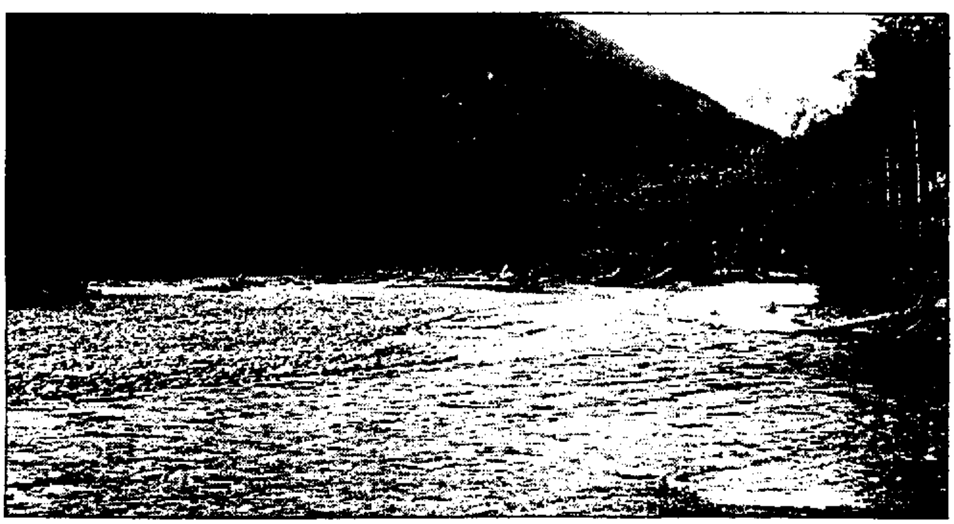
In the Dredge and Slurry alternative some of the fine-grained sediments would be removed by pumping them with water through a pipeline to the Strait of Juan de Fuca. This process would remove an estimated 75% of the silt and clay which would otherwise enter the river during dam removal. Instead of the 4.8 to 5.6 million cubic yards of fine-grained sediment that would erode from the reservoirs with the proposed action, 1.2 to 1.4 million cubic yards would wash into the Elwha River during dam removal and for the following 6 months.

Sand and gravel which formed the riverbed before the dams were built has eroded out to sea, resulting in a lowered or degraded river channel below the dams. This section of river channel is also "armored" with larger rocks (cobbles and boulders) and so moves at high river flows. The loss of riverbed material has severely degraded anadromous fish habitat, allowed vegetation to become firmly established on gravel islands and floodplains, and has reduced natural river meandering and lowered flood stage. This in turn has curtailed the formation of slower moving side channels, periodic wetlands or riparian areas.

Removing the dams and allowing sediment to erode would return sediment, including spawning gravel, to the river downstream and restore the river's natural river meandering and flood stage. Reestablishing the natural sediment load to the river would cause the river to aggrade and the water surface elevation to rise in some places. Vegetation which has grown in the floodplain may restrict the river's flow, and may be washed away by scouring as the riverbed returns to pre-dam conditions. These changes would occur with either the River Erosion or Dredge and Slurry alternative.

Flooding

"Aggradation," or the increase in riverbed elevation and associated increase in water surface elevation after dam removal, would be more pronounced in relatively flat areas. Modeling indicates aggradation would likely increase



Elwha River. (Curtis Miller photo)

over time, and would increase water surface elevations by as much as 1 to 4 feet in some spots on the river, but would average 2 feet.

Many of the homes, wells or cultural resources which would be affected are already in the 100-year floodplain and susceptible to flooding. Mitigating measures which would provide the present level of flood protection were examined; a description is located in the Impacts to Flooding section. At this time, raising and strengthening the Lower Elwha Federal Flood Control Levee and measures to protect municipal and/or industrial water users are fully integrated into both action alternatives. Other mitigating measures are not required by a specific law but are recommended to protect downstream residents and structures.

Surface Water

The reservoirs have affected water quality by acting as a large settling basin during floods, landslides or other events which would normally produce surges of turbidity downstream. During these events, a "slug" of sediment moves slowly through the reservoirs, which dampens peak turbidity levels downstream but extends them over a longer period of time. Turbidity during floods is therefore less intense but longer lasting because of the reservoirs. Removing the dams would reduce the longevity of turbidity events, but increase peak levels.

Surface water users would, for the most part, not be affected in either the short or long term by dam removal...

The dam removal process would also greatly increase turbidity(from a maximum of about 800 nephelometric turbidity units (NTU's) now to as much as 25,000 NTUs) for short periods of time (a few days), suspended sediment and possibly dissolved manganese and iron stored in reservoir sediments for the one to two-year period during dam removal. Using suction dredges to remove up to 75% of the fine-grained sediment would reduce peak turbidities to a maximum of about 10,000 NTUs for one to three day periods during dam removal. These are major adverse impacts to surface water quality. Minor changes to pH, temperature and dissolved oxygen would also occur during dam removal.

In the two to six years after dam removal, turbidity, suspended sediment and dissolved iron and manganese would settle to levels slightly to moderately higher than under conditions now. Turbidity would range up to 1000 NTUs, suspended sediment would average 69 ppm, dissolved iron 20–2,300 micrograms per liter, and manganese 10 to 700 micrograms per liter. Increased suspended sediment and turbidity would have a long-term moderate adverse impact on water quality; increased iron and manganese a long-term minor impact. Water temperatures would be decreased in late summer and fall as a result of dam removal. This would be a major beneficial impact to water quality and aquatic life. Changes in pH and dissolved oxygen would have negligible or minor impacts to water quality.

Surface water users would, for the most part, not be affected in either the short or long term by dam removal, as mitigation to protect them against adverse impacts of the action is required. An infiltration gallery and open-channel industrial pre-treatment would be used to treat surface water before serving the City of Port Angeles' two largest industrial customers, the Daishowa America and Rayonier mills. The third user of this water, the Washington Department of Fish and Wildlife fish rearing facility, would be closed during dam removal and chinook salmon production moved to another facility. However, the infiltration gallery would stay in place following dam removal and water collected in it would also supply the rearing facility when it reopens.

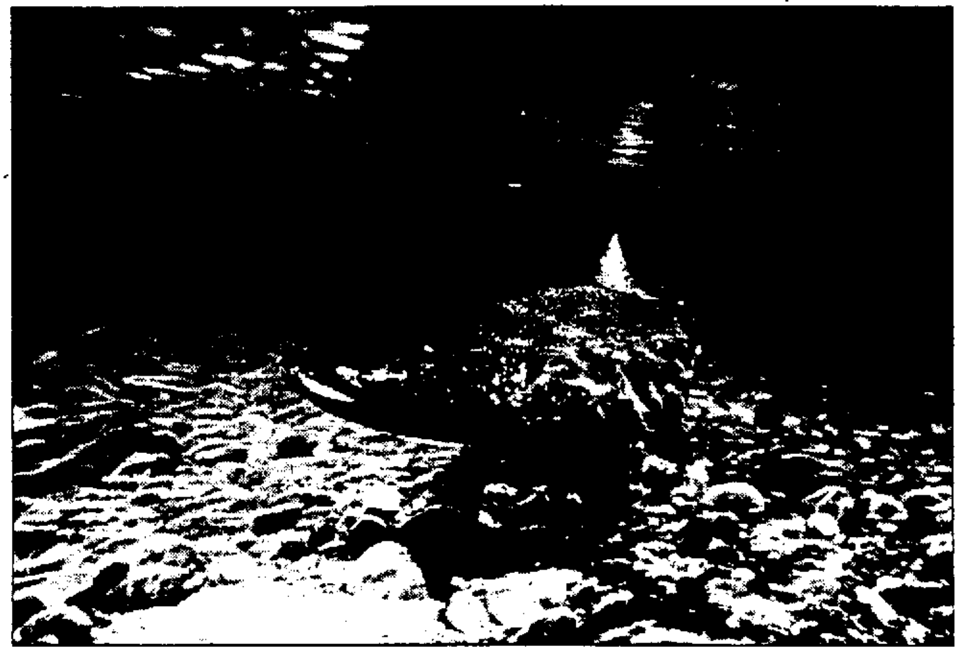
Groundwater

Groundwater users would be affected by changes to the river as a result of the dam removal process. Infiltration of fine sediments into riverbed substrate or through well screens would increase turbidity and/or decrease yield from the aquifer. Increased bedload of the river would promote renewed channel migration and bank erosion, which might affect yield. Riverbed aggradation would increase river stage, and wells might be overtopped and contaminated. Mitigation measures for Port Angeles, Dry Creek Water Association, and the Lower Elwha Tribal Fish Hatchery are mandatory and would effectively eliminate impacts of dam removal to these users.

A new Ranney collector installed on the opposite side of the river and upstream from the one which exists now would ensure uninterrupted and high quality municipal supplies for the City of Port Angeles. The Dry Creek Water Association (DCWA) could either connect to the Ranney well supply, or require a separate filtration and chlorination facility. Either would protect DCWA users from the adverse impacts of dam removal.

Several other users of Elwha River water, including Elwha Place Homeowners' Association (EPHA), individual well users and some residents of the Lower Elwha Klallam Reservation would experience adverse impacts during dam removal. Mitigation measures to protect each are analyzed in this DEIS and recommended for adoption. The proposed mitigation for individual well users is described in Impacts to Groundwater section. It includes raising wellheads, installing in-line filters and temporary storage tanks, drilling to deepen existing wells or create new ones, and a contingency fund. The Elwha Place Homeowners' Association might experience increased turbidity, dissolved iron or manganese and overtopping of their wells as a result of dam removal. Modifying wellheads, flood-proofing the pump house, and installing a temporary water treatment system would protect EPHA from any adverse impacts of dam removal. Without mitigation, these users could experience minor to major impacts from dam removal.

Several residents of the Lower Elwha Klallam Reservation would experience higher groundwater levels, rendering their septic systems unusable following dam removal. A mounded system with lift stations would resolve this impact. Non-structural solutions to resolve flooding and/or water quality problems might also exist.



Chinook salmon spawning behavior in the lower Elwha. (Natalie Fobes photo)

Native Anadromous Fisheries

Existing stocks in the lower river . . . would likely decline to extinction under the No Action alternative.

The dams and their reservoirs have directly affected salmon and seagoing trout by blocking access to all but the lowest 4.9 miles and by inundating 5.3 miles of what once was high-quality habitat. Salmonids are restricted by the dams to the lower 4.9 miles of river, and the problems associated with crowding into this space are exacerbated by the near-elimination of spawning gravel and by the higher-than-normal water temperatures that are present during some months — both of which are caused by the dams and reservoirs. Also, many species require slower moving water, riparian vegetation, or a fully functional estuary to spawn or rear, all which have been reduced by the elimination of natural sediment transport. The number of native anadromous Elwha spawning salmonids has dropped from an estimated 380,000 (or more) to fewer than 3,000 today (1995). Existing stocks in the lower river unsupported by artificial propagation (hatchery operations) would likely decline to extinction under the No Action alternative.

Removing the dams and draining the reservoirs would restore natural sediment transport, add 5.3 miles of riverine habitat, make accessible the entire 70+ miles of river the fish used before the Elwha Dam was built, and restore high quality habitat in the lower and middle reaches of the Elwha River. Estimates of the approximate number of each of the five salmon species (representing six runs, or stocks) and steelhead trout (representing two runs) which would return under these conditions, and the time to recovery assuming no hatchery intervention, are presented in table 2 below. For comparison, estimates of the number of wild production of each species occurring in the river now (i.e. No Action) are also included.

Table 2. *New Wild Salmonid Production and Recovery Time*[a] *(number of fish/year)*

	ACTION ALTERNATIVES (FULL RESTORATION)		NO ACTION[b] (EXISTING CONDITIONS)
	Number of Fish	Years to Recovery	Number of Fish
Chinook	31,000	21-25	1500-2000[c]
Coho	35,000	15-18	<500
Chum	36,000	18-21	<500
Pink	274,000	16-20	<50
Steelhead	10,000	15-18	<500
Sockeye	6,500	12-20	0

a Assuming no outplanting or hatchery production. Outplanting may reduce recovery time by as much as half.

b No Action (existing conditions) would not result in any new wild salmon or steelhead. These figures are estimates of current production of wild anadromous fish in the Elwha River.

c All Elwha chinook are considered a composite of wild and hatchery stocks.

Short-term Impacts

The release of sediment downstream during the two-year dam removal process would have major adverse short-term impacts on salmonids attempting to return to or spawn in the river. Most of these are hatchery fish which support commercial or sport fisheries, although some native fish do return and would be used as stock to restore Elwha runs.

The most pronounced effects of dam removal in the short term would be on adults. Since few, if any, adults entering the river to spawn during dam removal would be successful, egg or juvenile mortality would only be indirectly affected.

Adult summer/fall chinook begin their upstream migration in July and spawn in September and October. They would be most severely affected during the initial reservoir drawdown beginning in June of the first year, as well as by the complete dam removal work which begins in July of the second year and lasts through October. Some adults would enter the river and be killed by suspended sediment loads, and some would avoid the Elwha and stray into neighboring rivers during these periods. Although the same species would be affected in the same way under both the River Erosion and Dredge and Slurry alternatives, the degree of impact would be less if the bulk of the fine suspended sediment is removed first (as proposed with the Dredge and Slurry option).

Elwha sockeye salmon are considered extinct, and would be restored following dam removal using related stock from Lake Sutherland or a neighboring river.

They are therefore not expected to experience any adverse impacts from dam removal.

Work would be stopped twice during dam removal because of flood flows and to accommodate spawning periods for several species of anadromous fish. For 20 to 85 days beginning in November, work would stop and suspended sediment loads would drop to below 200 ppm, allowing chum, coho, winter steelhead and anadromous cutthroat trout to enter the river to spawn. Some of these adults would be captured and used to further restoration efforts. Work would again be stopped in April or May and continue for 80 to 100 days and suspended sediment would then drop to below 200 ppm (i.e. background levels). Spring chinook and summer steelhead adults would be able to enter the river and spawn during this period, although adults may be captured and used to help restoration efforts. During dam removal, some outplanting of eggs or fry in the reaches of the Elwha upstream of the reservoirs is anticipated. Juveniles resulting from these outplants would be able to migrate downstream following the completion of dam removal.

Vegetation

The dams and reservoirs cover a total of 715 acres, 684 of which were inundated by the reservoirs. This acreage includes more than 5 linear miles and 534 acres of low elevation riparian communities and natural wetlands, which are important in the cycling of water, nutrients, sediment, organic matter and aquatic and terrestrial organisms in the riverine ecosystem. Wetlands and riparian vegetation also reduce the severity of flood events, act as a buffer to pollution sources entering the river and provide important fish habitat.

Full vegetative recovery would take up to 100 years, assuming all measures identified in the Revegetation Plan (appendix 3) are implemented. Within 3 years, vegetation would begin to appear natural, and be stabilized enough to mimic pre-dam levels of erosion within 6 to 10 years.

Restoring habitat would be a major, beneficial impact to most local wildlife species.

Wildlife

At least 22 wildlife species are known to feed on salmon carcasses, eggs or juveniles in rivers in this region. The dams eliminated this source of food for these species from all but the lowest 4.9 miles. In other river systems in the Pacific Northwest, interactions between anadromous fish and terrestrial wildlife communities are central components of ecosystem function, and therefore of the maintenance of regional biodiversity. In the Elwha, it is estimated that salmon and steelhead would bring more than 800,000 pounds of biomass and 13,000 pounds of the essential nutrients nitrogen and phosphorus to the aquatic ecosystem if the dams were removed and natural ecosystem conditions fully restored. Restoring habitat would be a major, beneficial impact to most local wildlife species.

Species of Special Concern

The primary impact of the dams to species of special concern (threatened, endangered or rare) has been loss of habitat, although some have been affected by the loss of salmon as a food source. The bald eagle is an example of the latter.

Removal of the dams and recovery of the river's ecosystem would result in major beneficial impacts to the northern spotted owl, marbled murrelet, Pacific fisher, harlequin duck, bull trout, Vaux's swift, pileated woodpecker and several rare amphibian species.

Dam removal would adversely affect some species in the short term, primarily through construction noise. Murrelets and spotted owls may avoid the area if noise gets too loud. Surveys to date have shown no murrelet nests close to the damsites, but two consecutive years of data collection are required to fulfill US Fish and Wildlife Service procedures. If 1996 surveys confirm that there are no nests near the sites, mitigation would not be required. If they find nearby nests, mitigation including noise reduction or changes in the sequencing and timing of construction activities would be developed. Spotted owl surveys to date have not found nests near either dam, with the closest being nearly one mile from Glines Canyon Dam. As a result, adverse effects on northern spotted owls are not expected.

Long tailed weasel — a species that feeds on salmon carcasses. (Janis Burger photo)

Living Marine Resources

Different species of marine life now occupy the nearshore area by the Elwha River mouth than before the dams were built. This is largely due to substrate changes resulting from the elimination of natural sediment transport. Before the dams were built, it is likely that the substrate sizes were mixed and supported species like Dungeness crab, littleneck, butter, horse and geoduck clams, sand lance, surf smelt, eelgrass, and species of green algae. These species are expected to return following dam removal.

Substrate is now composed of large-sized material (cobbles, boulders, etc.) and supports kelp, rockfish, greenling, red rock crab, and chitons. This community of marine life would sustain moderate adverse impacts during dam removal as sand and gravel bury organisms, and silt and clay make the water turbid. Over the long term, the increase in transport of sand and gravel would result in a major change in the substrate composition and associated biological community between the river mouth and the eroding bluffs to the east. Future conditions, however, would approximate those that existed prior to dam construction. This is true of both action alternatives. The Dredge and Slurry alternative would send less suspended material offshore via the river, and would instead deposit it in offshore waters 60 to 100 feet deep. This location is preferred because currents are strong and would quickly disperse fine sediment, and reduce adverse impacts to marine life.

The return of natural sediment transport would help to restore beaches, which have become steepened in part because of the loss of sand from the Elwha River, and would help offset erosion of Ediz Hook.

Air Quality and Noise

Construction activities during dam removal would send minor amounts of traffic-related pollutants (i.e. ozone, carbon monoxide, sulfur dioxide and oxides of nitrogen), and some particulates into air in the immediate area. Other sources of particulates in the Elwha basin include burns, pulp mill emissions, vehicles and campfire smoke, all of which affect visibility.

Construction-related sources of particulates would include the use of haul roads, loading and dumping, bulldozing, saw cutting, blasting and wind erosion of the exposed reservoir basins. Emissions of particulate matter less than 10 microns (PM_{10}) from these sources at Elwha Dam are expected to be about 105.3 tons, and at Glines Canyon Dam, about 25.2 tons over the 18-month to 2-year dam removal time period. Although impacts would be temporary, dust along a portion of the dirt road entry into the Elwha damsite may moderately affect homeowners in the short term and require mitigation, such as spraying periodically with water, or paving the road.

Slightly greater particulate emissions are expected under the Dredge and Slurry alternative, as the pipeline would be buried for part of the route. This would entail digging and burying, which would send dust into the air. The amount is small enough that no measurable difference between the two alternatives is expected.

There are no homes or wildlife of special concern closer than 0.3 miles to either damsite. Twenty residents live within 0.6 miles of Elwha Dam, 55 within 1.2 miles and 491 within 3 miles of the site. Other than an employee residence at the dam, the closest homes to Glines Canyon Dam are 2 miles away, and four lie within a 3-mile radius. Nests of species of special concern (marbled murrelets and/or Northern spotted owls) have been located 1 mile from Glines Canyon Dam, and 1.2 miles from Elwha Dam.

Continuous noise levels from construction equipment could have short-term (18 months to 2 years) minor adverse impacts on residents living within one-half mile of the Elwha Damsite, but would not be noticeable beyond 1.2 miles. Ambient weather conditions and topography may reduce noise levels. Species of special concern would not be affected.

Residents within 0.6 miles of Elwha Dam would periodically experience short durations of acute noise from intermittent blasting similar in intensity to that of moderate thunder. Residents and wildlife beyond 1.2 miles would not be expected to experience blasting noise; predicted noise levels during the worst-case atmospheric conditions are all below or close to 120 decibels. Both continuous and acute noise levels would be temporary and are considered negligible impacts.

At Glines Canyon Dam, pre-splitting and blasting during notching of the dam would produce about the same level of noise as at Elwha Dam, and would be the loudest actions at the site. At a distance of 1 mile from the site, sound levels would have dropped to those comparable to distant thunder or lower. At two miles, the distance of all residences except the one at the dam, the sound has no effect.

Actual noise levels could be up to 20 decibels less than those predicted due to attenuation provided by trees and terrain that were not considered in this assessment.

Traffic noise would be comparable to a logging truck and would occur primarily along routes already used frequently by such trucks.

Cultural Resources

The hydropower projects have become historic properties and both are on the National Register of Historic Places. Removing them would mean the loss of the projects themselves, a major adverse effect under the National Historic Preservation Act. However, mitigation in the form of documentation of their properties to the standards of the Historic American Engineering Record would offset this loss. Also, some features of the Glines Canyon damsite would be left in place so that Olympic National Park could use them as a focus of interpretive activities in the future. Because of these measures, the significance of the resources would be preserved, and impacts for the purposes of this EIS (i.e. under NEPA) would be reduced to minor.

Elwha Dam.
(Charles Scott photo)

The damming of the river has had a profound effect on the cultural resources of the Elwha Klallam people. The Elwha Klallam have lived in and around the river valley for thousands of years, and their culture, spiritual traditions, and economy have become intermeshed with it and the resources it has traditionally provided. These resources include the salmon and steelhead which filled the river before the dams were built.

When the river was dammed, the quantity of fish in the river drastically declined. Cultural resources important to the Lower Elwha Klallam, including the site on the river where they believe their people were created, were inundated or made inaccessible by the reservoirs or buried by the dams. The damming of the river itself has had a major adverse impact on all of the cultural resources that a free-flowing river represent to the Elwha Klallam. Only removing the dams would return these resources — the natural flowing river, the abundant salmon and trout, and the irreplaceable cultural resources which lie along the river valley. This would be a major beneficial impact of the proposed action.

Removing the dams could adversely affect some historic sites, because the river is expected to both meander and experience an increase in flood stage over what it does now. Particularly at risk are those sites such as the Elwha Ranger Station Historic District and the Altaire and Elwha campgrounds' kitchen shelters which have been built in the floodplain since the dams were constructed. These same resources may be affected by road widening or staging for construction as well. Minor impacts to cultural sites may occur as a result of rubble disposal.

The agencies cooperating in the production of this DEIS, as well as other agencies, have signed an agreement which prescribes monitoring and mitigation for impacts to cultural resources. The types of mitigation include surveys, avoidance, and documentation of the features of a resource if it will be affected. Because of the mitigation spelled out in the agreement, adverse impacts to cultural resources would be minor.

The proposed action and the Dredge and Slurry alternative are expected to have similar impacts to cultural resources, except for those potentially caused by trenching to lay the pipeline if it follows an alignment along county roads. With mitigation, these additional adverse impacts to cultural resources would be minor.

Socioeconomics

The economic benefits of dam removal far exceed the costs. Marked benefits would be derived from additional recreation, tourism, and sport fishing expected in the area after the dam removal, totalling $164 million over the 100 years of project life (at a 3% rate of discount). While data underlying nonmarket estimates of value are more variable than market estimates, the nonmarket value of restoring the Elwha River salmon and steelhead fisheries and returning the ecosystem to its natural state has been estimated at $3.5 billion per year over ten years (Loomis 1995).

The economic benefits of dam removal far exceed the costs.

Activity associated with the removal of the dams would generate between 1,150 and 1,240 jobs in Clallam County during the approximate 10 years of pre-construction, construction and restoration involved in implementing the project. This, in turn, would generate an estimated $60-$65 million in business activity and another $32 to $34 million of personal income locally. After restoration is complete, 446 permanent jobs and a corresponding annual payroll of $4.6 million would be generated in the Clallam County recreation and tourism sector. Increases in the workforce are not expected to generate any significant change in the need for public services.

The proposed action is estimated to cost $111.1 million, and the Dredge and Slurry Alternative, $124.4 million. These cost estimates may decline at final design stages.

Public Health and Safety

Three variables: overall dam safety, potential for damage due to earthquakes and impacts from hazardous materials were analyzed. Although Glines Canyon Dam is considered strong enough to withstand even a probable maximum flood or major earthquake, a recent Department of the Interior pre-acquisition inspection of Elwha Dam noted such "remotely occurring events" may cause "a dam deficiency" (DOI et al. 1995). The probability of an earthquake on either shallow crustal faults in the area or deeper subduction faults is unknown, but is probably remote. Because damage to downstream residents in the event of dam failure would be great, the dams are rated as having high hazard potential.

Special care would be taken during the removal of the Elwha Dam to ensure there is not a failure from the dam foundation as occurred during its construction in 1912. A series of cofferdams and other measures are integrated into the removal design to ensure public health and safety during dam removal.

Asbestos, PCBs, and chemicals such as fuels, paints, lubricants, and pesticides were found in the project area. These are contained in soil, transformers, wiring, associated buildings, and batteries at both powerhouses. The areas would be cleaned up by remediating and removing the contaminated materials from the dams and associated buildings and transporting them offsite to a licensed hazardous waste dumpsite under either action alternative.

Traffic

Impacts to traffic would occur as a result of trucks carrying equipment and personnel to and from the site, and carrying rubble and waste materials away. They would last only during the construction period, and would peak during the final 7 months of Elwha Dam demolition.

Nine different waste disposal areas were analyzed. Traffic information generated for 13 major intersections through which trucks would need to pass was also assessed. The addition of project traffic would cause only one intersection to decline in its level of service (LOS) rating during peak hours. Two construction years were analyzed, 2000 and 2005. Assuming the maximum number of trucks entering and leaving the Elwha Damsite (16 trips per hour — 8 each way) during the year 2005, the intersection rating of US 101 and SR 112 would fall during the peak traffic hour from LOS B to LOS C. This means the time spent stopped or delayed at the signal at this intersection would increase from a range of 5 to 15 seconds up to a range of 15 to 25 seconds. This impact is minor and temporary.

Impacts from project traffic to all other intersections during peak hour traffic on both weekends and weekdays would be negligible.

There may be concerns about truck traffic entering the highways from the site access points at Power Plant Road and Olympic Hot Springs Road. As a safety measure, flaggers may be used at these intersections to facilitate the introduction of trucks to the busy arterial roadways.

Indian Trust Resources

Glines Canyon Dam. (Charles Scott photo)

The dams have harmed resources secured to the Elwha Klallam and other tribes under the Treaty of Point No Point, and the Treaty with the Makah, signed in 1855. Under these treaties, tribes retained the right to take up to one-half of the harvestable fin and shellfish returning to usual and accustomed fishing places (except for "staked or cultivated beds"). The dams have reduced the number of harvestable fish to near zero (without hatcheries, all native anadromous runs would likely eventually die out), and greatly reduced both sandy substrate and the Elwha estuary beneficial to shellfish. Both of these impacts are major and adverse, although impacts to shellfish have not been quantified.

In addition, the federal government is obliged to protect Indian trust or restricted lands in the Elwha River drainage. The near-elimination of sediment transport beyond the dams has resulted in major erosion of tribal beaches. Also, the risk of failure of Elwha Dam (from very large earthquakes or floods) is unknown, but considered unacceptable by the tribe at this time until further safety analyses are completed.

Removing the dams and draining the reservoirs would restore conditions under which fish and shellfish would flourish, eliminate the risk of Lower Elwha Klallam Reservation flooding from dam failure, and reverse reservation beach erosion. Either action alternative would uphold the federal trust responsibility, and have major beneficial impacts to resources subject to it. The No Action alternative would continue major adverse impacts to these same resources and would not uphold the federal trust responsibility.

Recreation

Local residents use both reservoirs for fishing and boating and the loss of this recreational resource would be a major impact to them. Nearby lakes, such as Lake Crescent and Lake Sutherland, are expected to accommodate users from Lakes Aldwell and Mills, and would be slightly more crowded as a result. Out of town visitors would only experience a minor impact because of the availability of other lakes in the area.

During construction (about two years), the Elwha subdistrict of Olympic National Park would be closed to visitors. This would impact an estimated 140,000 (1993) to 170,000 (1994) visitors using the Elwha River valley inside the park each year, including hikers, campers, sightseers, picnickers, fishers, boaters, horseback riders, and backpackers. Shuttle service in the valley would mitigate some of this impact. Restrictions on sport fishing during dam removal and restoration of native anadromous salmon and trout may adversely affect both marine and in-river recreational fishers for up to a decade or more in some cases.

In the long term, both the River Erosion alternative and the Dredge and Slurry alternative would increase river recreational opportunities and would have a major beneficial impact on salmon and steelhead sport fishing in the Elwha River valley and Clallam County.

Land Use

Use of lands associated with the Glines Canyon hydropower project is inconsistent with policies governing land use inside Olympic National Park. These policies are designed for lands either designated as wilderness or that are in a relatively natural state. When the dams are removed, the park would maintain some features of the damsite for their interpretive value but otherwise the land would be revegetated and managed for backcountry/wilderness uses. This would conform with National Park Service policies and would be a permanent beneficial impact. The objectives of several regional and local land use plans would also be achieved.

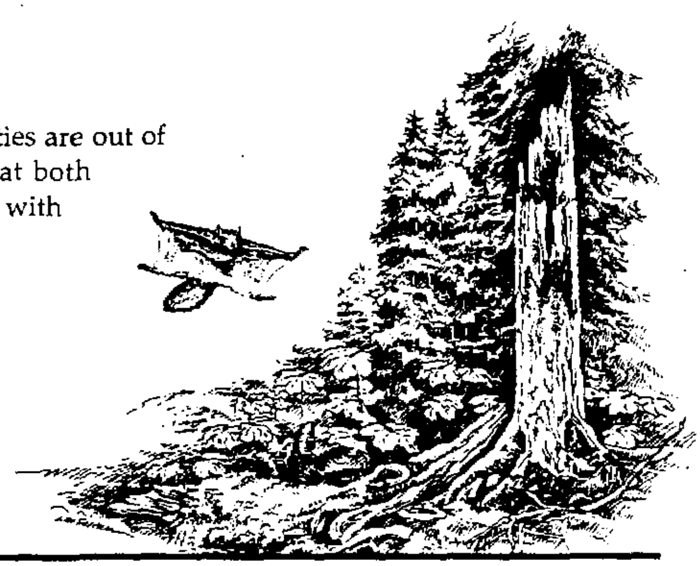
Lands associated with the Elwha hydropower project are outside park boundaries and are designated by the Elwha Restoration Act to revert to one of four managers. Two of these (the US Fish and Wildlife Service and the Washington Department of Natural Resources) are not interested in acquiring and managing the lands, particularly if access to the river is maintained. The third, Olympic National Park has stated the lands qualify for inclusion in the park, but is not pursuing their inclusion in the park. The fourth party, the Lower Elwha Klallam Tribe, is interested in managing the lands and has proposed some use of the lands away from the river for natural resource management, housing, and/or economic development. Any land manager is required by the Elwha Restoration Act to protect fisheries and ecosystem restoration.

Disposing of over 210,000 cubic yards of concrete and fill materials and 730 tons of mechanical and electrical equipment from the demolished dams would permanently commit land to this use, but may reclaim sites unusable now (such as surface gravel mines).

Aesthetics

The dams and associated hydropower facilities are out of character with the surrounding landscape at both sites, and contrast in form, color and texture with that landscape.

Removing the dams and draining the reservoirs would expose two large, flat expanses visible to visitors and/or passengers along Highway 101. Dust from the lakebeds would impair visibility during windy days until vegetation takes hold (the



year after the reservoirs are drained). As time passes, vegetation would become more varied and the area would eventually begin to appear natural. If shorelines and other upland areas are revegetated as proposed, the sites would return to the climax forest stage within several decades.